Biomorphic Loop: Visualising patterns of growth

by

Linda Erceg BEd (Hons), MFA

Tasmanian College of the Arts

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Declaration of Originality

This thesis contains no material which has been accepted for a degree or diploma by the University or any other institution. To the best of my knowledge and belief, it incorporates no material previously published or written by another person except where due acknowledgment is made in the text.

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ABSTRACT

This project investigates how plastic fibres can be manipulated to create artworks that visualise the growth, adaptability and collapse of living systems. Drawing on a number of mathematical and scientific concepts used to interpret patterns in nature, I have created sculptural forms that explore modularity, repetition, scale-ability, connectivity and the dynamic tension between order and chaos that underpins all growth. My studio investigation focusses on manipulating a variety of plastic fibres, transforming these materials through the basic stitching processes of looping, knotting, binding and threading as an analogue for growth processes. In particular, the ability of the crochet stitch to continuously expand into complex foldings and interconnections is used to investigate organic patterns of growth including: spherical; branching; crenelated and fractal forms. The resulting artworks have a real world ecological context in the discarded plastic debris and fishing 'ghost nets' that are accumulating in the ocean. Representing a system that is growing and self-generating, the problem of plastic waste becomes a timely analogy for the way in which benign patterns of growth can become malevolent and dangerous.

The visual context for this project is informed by the work of contemporary artists who rigorously engage with their chosen materials in order to explore the images and ideas of growth. Ruth Asawa, Margaret and Christine Wertheim and Tara Donovan all produce sculptural works through the application of rules and

iterative repetition. While referencing scientific and mathematical theories, they interpret rather than imitate the generative possibilities of biological modelling of pattern. Eva Hesse, Ernesto Neto and Lucy Irvine also investigate iterative processes, however their primary focus is on discovering the expressive potential of their materials through structures that elicit metaphorical triggers and associations.

As this project has evolved, I have given more emphasis to disordered, transient and ephemeral qualities. Having no beginning, middle or end, my various sculptural elements connect in formations that are infinitely reconfigurable and adaptable. These open-ended and flexible qualities align my project with the concept of the 'rhizome' as proposed by Deleuze and Guattari and to the associated concepts of contemporary complexity theory and the formation of emergent, self-organising structures. In tandem with these theoretical underpinnings, my project also references the culturally loaded symbolism of fibre, evoking both a linear pathway and a stitched boundary that enables connection, separation or containment.

During the course of this project, a series of test installations have given valuable insights into the potential for meanings to shift as materiality, structural shape, connectivity, scale, space and lighting are investigated as experiential elements. The culmination of these findings is presented in the thesis exhibition, comprised of gallery-based artworks focussing on a series of interrelated sculptural

installations. This project concludes that the processes of stitching can be used to manipulate and transform plastics so that they reveal their true material nature as an infinitely malleable shape-shifter and invasive, ecological coloniser.

ACKNOWLEDGEMENTS

This thesis is dedicated to the memory of my brother, Michael Erceg, 1978 – 2015, whose fearless and passionate love of life and music will always be an inspiration for me.

I wish to extend my sincere thanks to my supervisors, Anne MacDonald and Llewellyn Negrin for their unfailing support and guidance throughout my project. I am particularly indebted to my friends and fellow post-graduate colleagues who engaged with my test installations with invaluable critique, curiosity and encouragement. I also wish to thank Les Allester for his time and expertise in assisting with the installation of my examination submission.

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INTRODUCTION

The aim of my studio based research project is to investigate how plastic fibres can be manipulated to create artworks that visualise the adaptability, growth and collapse of living organisms and systems. My project explores ways in which patterns of growth can be visualised and conceptualised through the malleability of plastics and the processes of stitching.

Drawing on a number of mathematical and scientific concepts used to interpret patterns in nature, I create sculptural forms that explore modularity, repetition, connectivity and the dynamic tension between order and chaos that underpins all growth. My studio investigation focusses on manipulating a variety of plastic fibres, transforming these materials through the basic stitching processes of looping, knotting, binding and threading as an analogue for growth processes. In particular, the ability of the crochet stitch to continuously expand into complex foldings and interconnections is used to investigate organic patterns of growth including: spherical; branching; crenelated and fractal forms. The resulting artworks have a real world ecological context in the discarded plastic debris and fishing 'ghost nets' that are accumulating in the ocean. Representing a system that is growing and self-generating, the problem of plastic waste becomes a timely analogy for the way in which benign patterns of growth can become malevolent and dangerous.

Project Development

The title of my project - Biomorphic Loop – articulates key aspects of my investigation. Composed of the Greek words 'bio' and 'morph', meaning life and shape respectively, it can be understood as 'the shape of life'. Historically, the term 'biomorphism' refers to the "concept of forms created by the power of natural life" and it has been applied to artworks that "express metaphors of cyclic transformation" or "convey a sense of creation and evolution" (Turner, 1996 p.74). For my project, I use the word 'biomorphic' to also suggest curvilinear, non-geometric, organic forms that are capable of changing shape, transforming and adapting.

I include the word 'loop' in my title as it has several important connotations for my project. As a physical act, it describes the curving or doubling of a length of fibre over itself, which is the basic stitching process that I use to create my forms. I also refer to the word 'loop' in terms of a cyclical action, a lifecycle and an unfinished and unfinishable process that is constantly in the making. It denotes a repeated gesture and most importantly, the desire to repeat that action, to iterate, to experiment and be surprised. I enact a 'biomorphic loop' through my desire to engage with an evolutionary process of making where the forces of variation, mutation and natural selection propel the project forward. It is an engagement with processes that are meditative, compulsive and playful and where the search for transformation and meaning is constantly reinvigorated and in flux.

Through refining the scope of my project, materiality has been identified as a crucial factor in the development of my work. Making my first attempts to 'visualise patterns of growth' with natural fibres, the structural limitations of these soft materials caused me to reconsider my options. My decision to use plastic fibres such as: monofilament fishing line; nylon rope; synthetic hair and garden mesh, created a significant turning point in this project. While initially a pragmatic choice, this shift also gave me the opportunity to explore a range of concepts that relate to contemporary ecological themes.

In order to explore these ideas, I have framed my project around the following research question:

- How can the material and metaphorical language of plastic fibres be used to create artworks that visualise the growth and collapse of living systems?

Further, I have considered this central question to be composed of two parts:

a) How can patterns of growth be visualised?
b) How can the material and metaphorical language of plastic fibres be employed to achieve this?

I address these questions in my PhD project and discuss this investigation in my exegesis which has been structured into three main chapters and a conclusion.

Chapter One outlines the ideas informing my work. I begin by investigating how mathematical and scientific concepts can be used to visualise the patterns of growth found in living organisms, examining how analogue models have been expanded and developed through contemporary complexity theory, which applies a biological analogy to the understanding of any generative system. The metaphor of the rhizome, as proposed by Deleuze and Guattari is employed to conceptualise growth as a transformative and infinitely expanding system that can be physically manifested through the connective properties of plastic fibres. As the primary material for my project, I identify and explore the metaphorical associations and ecological implications of plastic fibres, through a discussion of the notions of embodiment, entropy and waste.

Chapter Two provides a context for my project, and locates it within the contemporary art field. This chapter begins with the work of Ruth Asawa, Margaret and Christine Wertheim and Tara Donovan who all explore the ideas and images of organic growth through works that are created by the application of rules and iterative repetition. In the second half of this chapter, my focus shifts to Eva Hesse, Ernesto Neto and Lucy Irvine, who extend their iterative processes through studio explorations that reveal the expressive and metaphorical potential of their signature materials. This investigation seeks to

identify the many strategies used by these artists, as they interpret rather than imitate the generative possibilities of biological systems, creating artworks that visualise the growth, adaptability and collapse of living systems.

In Chapter Three I discuss how my project has developed through a series of studio investigations and test installations. I investigate how the properties of plastic fibres - their colour, texture, density, weight, porosity and drape - combined with the organisation and patterning of connective stitches, loops, knots and ties, suggest a range of metaphoric interpretations that draw on the symbolism of pathways, connections, cocoons, webs, nets, pouches and a variety of organic associations. This chapter is supported by photographic documentation of material and spatial experimentation as well as detailed summaries of significant findings. This includes the way in which crochet as well as other basic stitching processes such as knotting, tying and threading are used as an analogue for growth processes. It also demonstrates how my studio investigations are used to understand and address issues of form, modularity, repetition, scale-ability, connectivity and most importantly, the material tension between order and chaos that underpins all growth.

The conclusion summarises innovative aspects of my project and key contributions to the field. This includes how the manipulation and transformation of plastics in my artwork creates new understandings of personally and socially constructed meanings of growth. Framed in a

contemporary ecological context, my project allows plastics to reveal their true material nature as an infinitely malleable shape-shifter and invasive ecological coloniser. The culmination of these findings is presented in my thesis exhibition which is comprised of gallery-based artworks focussing on a series of interrelated sculptural installations.

PART ONE: VISUALISING PATTERNS of GROWTH

The creation of forms in nature

My studio work is underpinned by research into the ways in which patterns of information, inherent in mathematical and biological models of growth, can act as a vehicle for art and design practice. From a philosophical and scientific point of view, patterns are part of the visual, psychological and material tension between order and chaos that underpins all life on earth. These patterns can be seen in the large and complex forces that create weather fronts and geological formations as well as in the microscopic and intimate cellular processes that regulate the maturation of organisms through cycles of growth, reproduction and death.

Significantly, in contemporary art culture, there has been a resurgence of interest in patterning, with artists challenging the idea that pattern functions simply as ornament and decoration. Discerning patterns in living and non-living systems has increasingly become the subject of scientific study in the last two decades. This coincides with a renewed interest in systems thinking, particularly focussing on cross-disciplinary complexity theories. The emergence of a 'data aesthetic' enabled by the pattern generating capacities of digital software has also provided a new context for imagining and visualising these complex models.

In order to develop my research project, I have sought out a range of scientific and mathematical theories that are prominent in the biological modelling of pattern and where possible, identify how these are reflected in contemporary works of art and design. In her essay "Pattern and Complexity in Art and Nature", Margot Osborne describes the various strategies that artists use when engaging with scientific thought. She claims, "While scientists work with hypotheses based on testable data, artists have the creative freedom to draw on scientific philosophy for metaphors… (and) find in the hard-won factual basis of scientific theories the stimulus for creative extrapolation and invention" (Osborne 2012 p19).

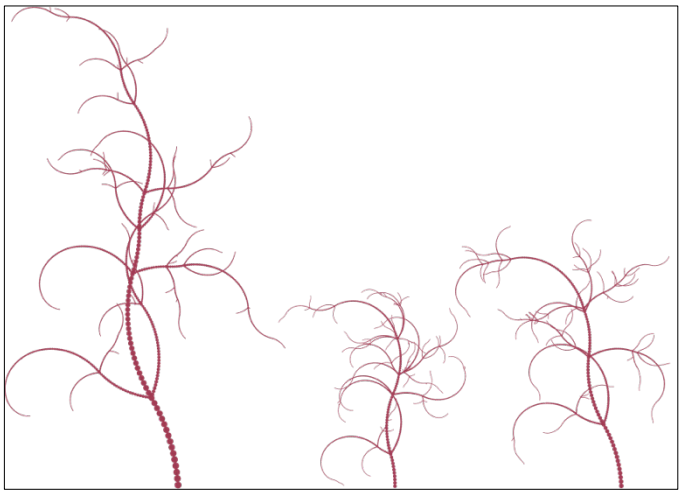


Figure 1: Recursive Trees – Computer generated model.

The rules of growth

Current understandings of the patterns and shapes in nature are underpinned by a long and diverse history of investigation. One of the key pioneers in this field was the biologist and mathematician D'Arcy Thompson who published *On Growth and Form* in 1917. He proposed the concept of 'morphogenesis' as the

process by which patterns are formed in plants and animals; coined from the Greek, it literally means “beginning of shape”. Thompson hypothesised that the structural shapes of biological forms obey the laws of physics and mathematics.

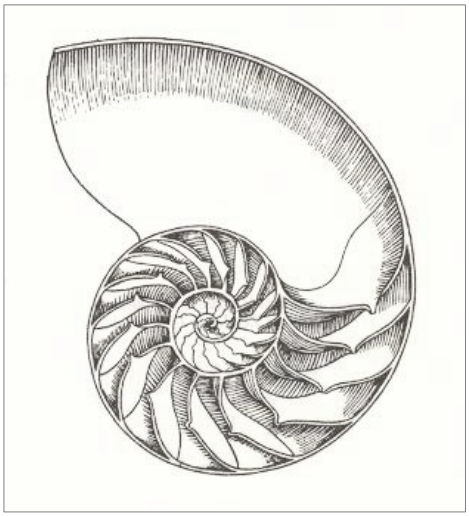


Figure 3: Illustration of the spiral arrangement inside a nautilus shell.

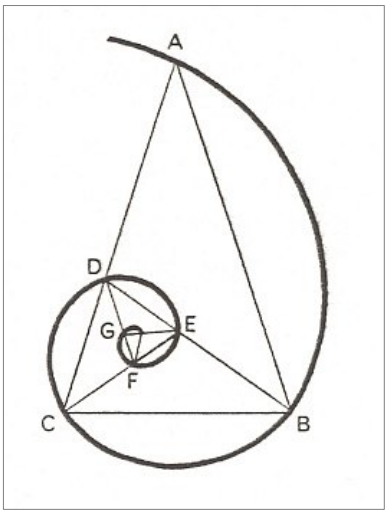


Figure 2: Schematic for spiral growth

Most famously, Thompson applied this theory to the study of spiral growth in animals (snail shells and rams’ horns) as well as the spiral arrangement of leaves on a stem, seed-heads and pinecones. He discovered that an underpinning rule in these growth patterns was the Fibonacci number sequence, (a series where each number is the sum of the two preceding numbers: 1,1,2,3,5,8,13,21,34…). Using this number set to predict growth intervals between states of change such as dividing or change of direction, allowed him to create predictive models of branching and exponential spiral growth.

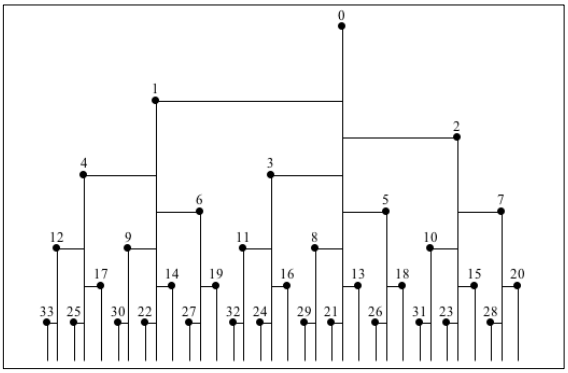


Figure 4: Schematic for the Fibonacci number sequence.

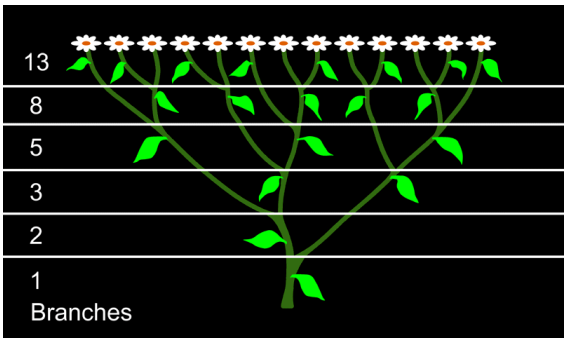


Figure 5: Schematic using the Fibonacci number sequence to model branching plant growth.

Thompson's chief legacy is his theory that patterns of growth and the resulting complex shapes found in nature, are derived from the repetition of simple rules over intervals of time. By proposing that all life is guided by number sets and organisational principles, Thompson also provided a way of uniting the shapes, patterns and structures seen in primitive, single-celled creatures with those of higher organisms. As the precursor of contemporary modelling of living systems, his theories of Morphogenesis give a highly quantified and systematic approach to interpreting a diverse range of organisms and understanding the forces that have shaped their shared structural forms.

Modelling growth through computational models

Mathematical principles are highly effective in modelling growth patterns. However, geometric shapes cannot easily describe organic forms as they are not perfectly regular or symmetrical. In his book *The Fractal Geometry of Nature* (1977), mathematician Benoit Mandelbrot states: “clouds are not spheres, mountains are not cones, coastlines are not circles, and bark is not smooth, nor does lightning travel in straight lines” (1977, p.1). Mandelbrot investigated how complex systems can be built up from the repetition of simple shapes and was the first to use computers to visualise the resulting patterns. In doing so he was able to achieve the vast numbers of iterations needed to be able to visualise the potential of his model to describe infinite self-similarity. What resulted was a new branch of Mathematics, which he called ‘Fractal’, based on its Latin derivation, meaning both ‘fragmented’ and ‘irregular’.

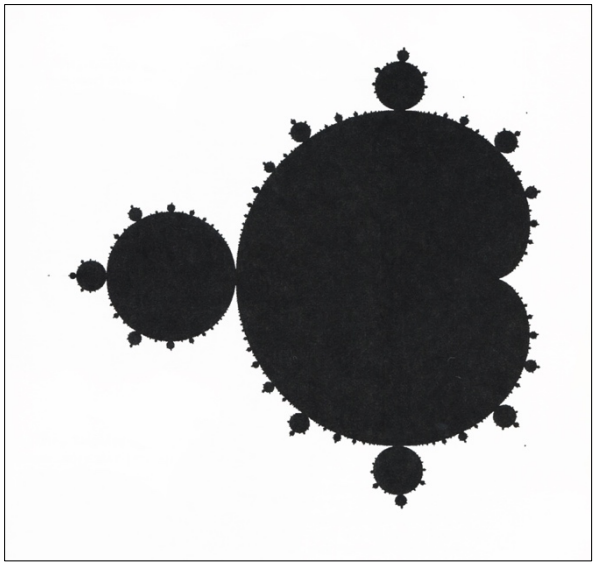


Figure 6: The Mandelbrot Set

The concept that nature is made up of irregular and nested self- similar shapes was visualised through computer-generated systems of growth that produced patterns reminiscent of organic motifs – spirals, branches, blobs and clusters. Peaking in the early 1990's, the popularity of the Julia and Mandelbrot sets marked the beginnings of a 'digital art' aesthetic and an awareness of the ability to visualise chaotic systems, such as the potential for infinite growth, through the patterns they produce.

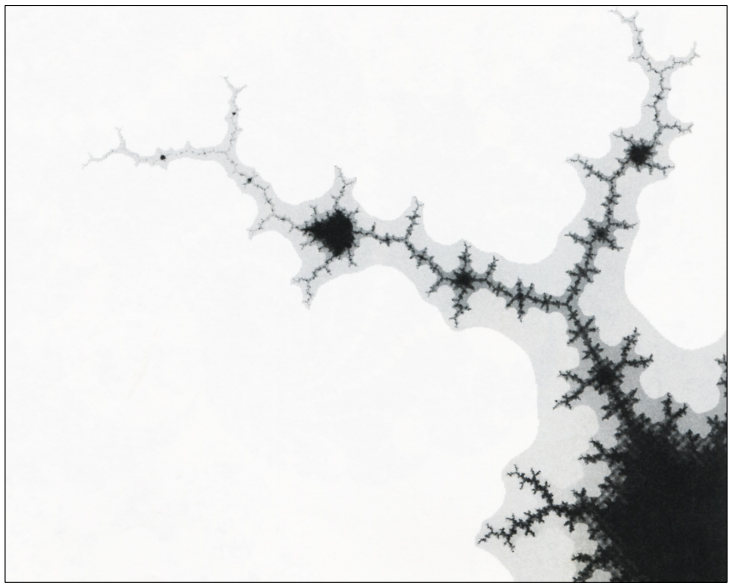


Figure 7: Detail of a Mandelbrot Set showing a 'corona' and 'spout'.

The fundamental concept behind Mandelbrot's fractal theory - that complex systems can be grown from successive iterations of simple rules - has become one of the lasting legacies of his work. His ability to see the potential of fractal geometry to "investigate the morphology of the amorphous" and to quantify irregular organic shapes often described as "grainy, hydra like, in between, pimply, pocky, ramified, seaweedy, strange, tangled, torturous, wiggly, wispy,

(or) wrinkled" (1977, p.5) has been used to understand the 'roughness' of natural forms.

Mandelbrot's concept of a 'fractal dimension' is still used to measure the number of 'self-similar' repetitions that are found in the whole structure where the same shapes are repeated again and again in decreasing scales in a natural form, such as a twig resembling a branch, which resembles the whole tree. Fractal geometry is also applied through the concept of 'fractal templates of nature', which identifies and relates the same shapes in different scales and across organic and inorganic forms. This concept is often illustrated by referring to the similarity of various branching structures such as the human circulatory system, a tree, a river system and the veination of a leaf.

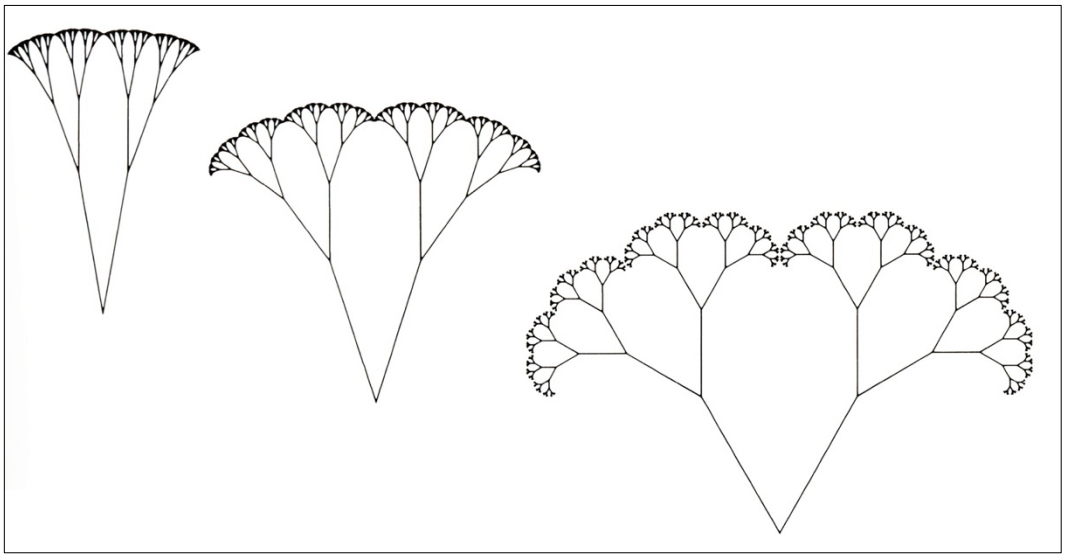


Figure 8: Benoit Mandelbrot - Fractal Umbrella Trees.

More recently, an understanding of fractals has been applied to the computer simulated modelling of a type of branching pattern found in corals and mineral dendrites, called Diffusion Limited Aggregation (DLA). Modelling this growth begins with a 'seed', with other particles 'spawned' in the vicinity of this seed. These particles then move around randomly and will either escape, or hit and 'stick' to the seed and each other. The extent of the particle 'stickiness' is one of the key variables in determining how 'hairy' or solid the overall form will become. The descriptive words used to conceptualise this type of growth - "seed, spawn, sticky, hairy", give another dimension to the way in which this model can be understood. It shifts from simply being an abstract mathematical algorithm to a way of visualising the active, physical processes of living systems.

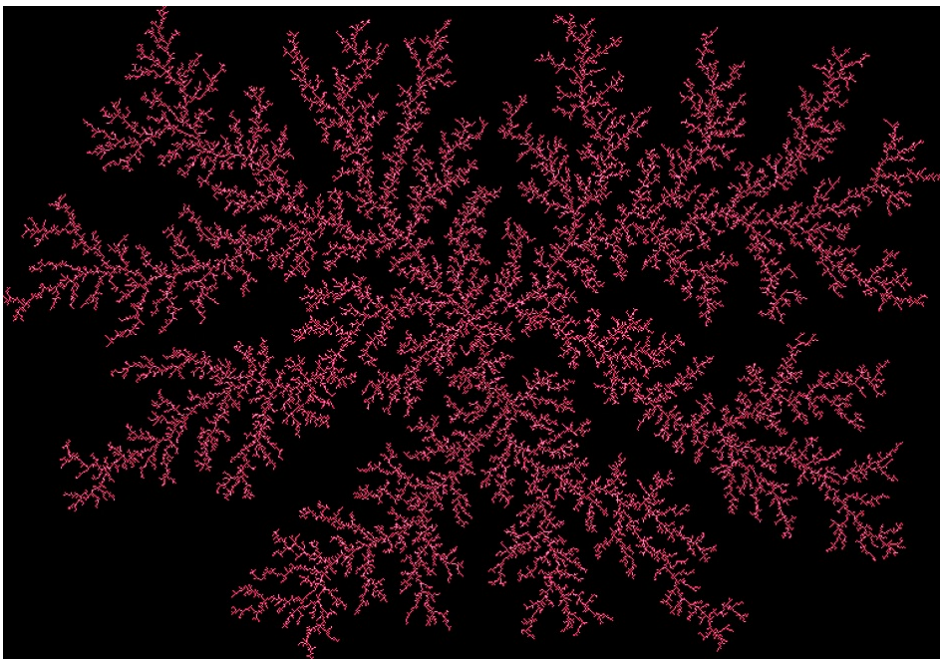


Figure 9: (DLA) Diffusion Limited Aggregate, Computer generated model of growth, rendered as a two-dimensional model.

As a two-dimensional model, the DLA algorithm can produce a variety of branching schematics, however in three dimensions, the complexity of these structures becomes much more evident. With infinite computer modelling iterations, it is possible to create very life-like models that demonstrate the crenelated irregularity and roughness found in natural forms. Mandelbrot's concept of fractal dimension can be fully realised using contemporary computing technology which makes it possible to visualise the complex patterns of iterated self-similarity.

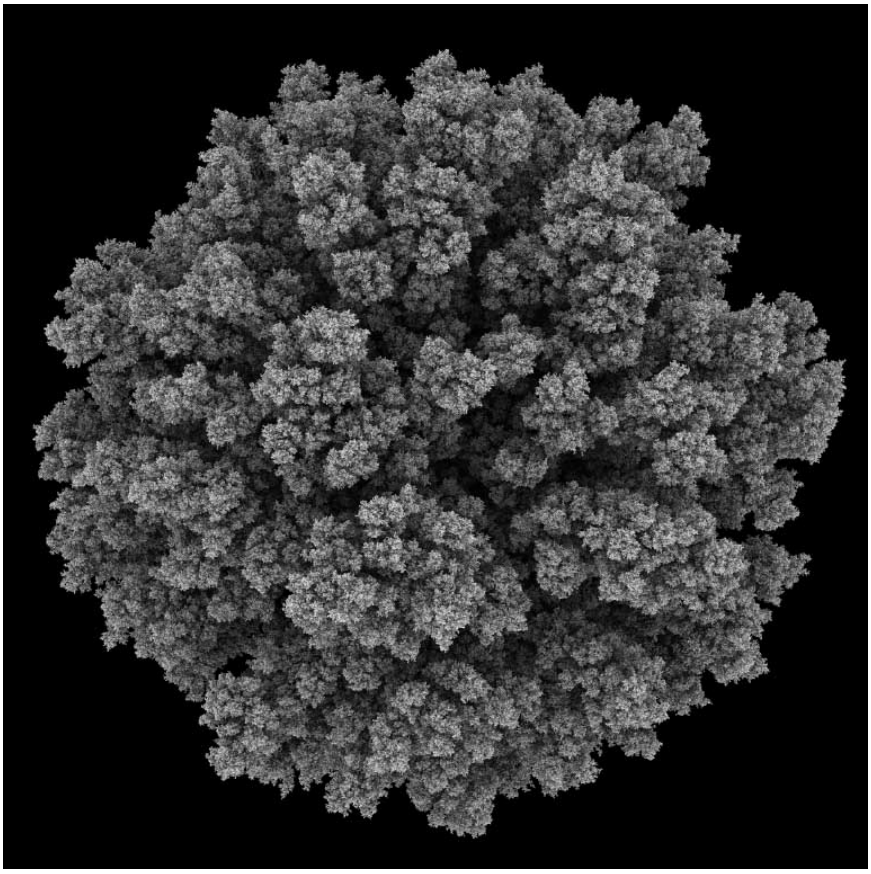


Figure 10: (DLA) Diffusion Limited Aggregate, Computer generated model of growth, rendered as a three-dimensional model.

The theory of an underlying fractal dimension to all living organisms can also be used to understand the inherent tension between order and disorder found in the biological world. At an atomic level, forms are composed of the tidy geometry of atoms. However, with the influence of environmental conditions, growth becomes less ordered and more fragmented and irregular. An example of this is the complex shape of a tree, which is based on one rule: 'grow then divide'. However perfectly this can be modelled, there is no 'perfect' tree as the intervals and angles of growth are affected by environmental factors (availability of nutrients, water and sunlight), internal factors (infection and aging) and external conditions (the action of wind and animals.) As changes, adaptations and mutations occur, they are copied and iterated to create patterns of growth that are inflected with these deviations.

Figure 11 -12, Linda Erceg, Studio investigations.

Summary

All living organisms are involved in a dynamic relationship with their environment, which means that growth is not a consistent system but requires

constant self-management and adaptation. Irregular patterns of growth such as the fractal structures of branching systems are found everywhere throughout nature. There is comfort in recognising this visual similarity as it shows that the potential chaos of the world is organised through simple patterns that are repeated in living and non-living systems.

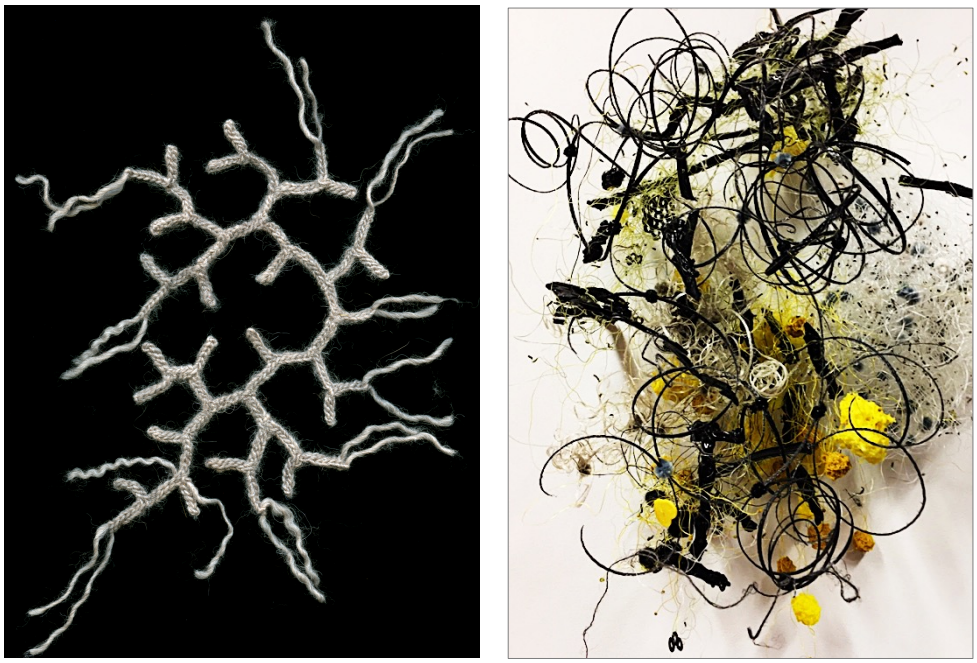


Figure 13 - 14: Linda Erceg, Studio investigations

Throughout my studio investigations, I have sought ways in which to contrast the systematic order imposed by number systems with the effects of random deviation, chance and mistakes. In doing so, I aim to 'visualise patterns of growth' through an iterated evolutionary process that is responsive to the dynamic forces of variation and adaptation inherent to all living systems.

PART TWO: MAPPING THE COMPLEXITY OF LIFE

A new paradigm of complex systems

Patterns and the shapes they create are seen everywhere in daily life. They appear in the organic world of plants and animals as well as the inorganic world of crystals, sand dunes, clouds and water flow. One of the most prolific writers on how mathematics can be used to understand the patterns in nature, is the scientist and journalist Philip Ball. He has released a number of related titles including: *Nature's numbers* (1995); *Life's other secret: The new mathematics of the living world* (1999); *The self-made tapestry: Pattern formation in nature* (2001), and more recently - *Nature's patterns: a tapestry in three parts – Shapes, Branches and Flow* (2011).

Figure 15: Mineral dendrites

Figure 16: Microscopic view of radiolarian exoskeletons.

A common theme in the narratives of these books is the quest for a unifying theory of life that breaks down the boundaries separating organic and inorganic,

plant and animal and microscopic and cosmic. His writing shows how this search has led to a renewed interest in systems theory and thinking. First proposed in 1930's by biologist Ludwig von Bertalanffy, systems theory "shifts attention from the absolute qualities of individual parts and addresses the organisation of the whole….as a dynamic process of interaction among constituent elements." (Shanken 2015, p.13)

Philip Ball uses systems theory to explain the prevalence of generic patterns such as spirals, hexagons, branches and spheroids. In his writing, these forms are conceptualised as functional patterns produced by the most economical use of energy, materials and space available to that system of growth. In doing so, he claims that nature finds the most efficient solution in the creation of every structure in the world: from the spherical packing of bubbles, the regular hexagonal networks of honeycombs and the staggered arrangement of leaves on the stem of a plant. Ball draws heavily on contemporary developments of systems thinking called 'complexity theory' and its principle concepts of 'self-organisation' and 'emergence'.

In a self-organising system, "order is not imposed by the environment but is established by the system itself." (Capra 1988) It is where the 'whole can be seen in the parts', meaning that the local 'rules' and interactions between individual components create a dynamic process of internal regulation and feedback. This results in an overall pattern that can be seen at smaller and larger scales. 'Self-

organisation' expands on mathematical number sets such as the 'fractal tree' and 'DLA' modelling to create a new interdisciplinary concept with widespread applications.

A related, though very different concept is that of 'emergence'. This term is used to describe "the properties of the system that cannot be deduced from its components, something more than the sum of its parts." (Weinstock 2004) In these cases, the dynamic interactions of the smaller entities give rise to a pattern that is surprising and often difficult to predict. Emergent properties can be found in the group behaviours of many animal species such as the flocking of migratory birds, swarming of locusts and schools of fish. 'Emergence' is an evocative term that suggests processes that are dynamic, shifting and transformative.

Recently, the availability of software that can turn data sets into static or dynamic visualisations has resulted in a proliferation of images of complex network schematics. This contemporary 'data aesthetic' is visualised through various mixtures of connective patterns - linear, cellular, branching, stratified, spreading and clumping, all of which have analogies to biological patterns of growth. The principles of Complexity theory are used to interpret the forms and processes of these systems, identifying the ways in which they can grow and proliferate as well as the factors that make them vulnerable to collapse.

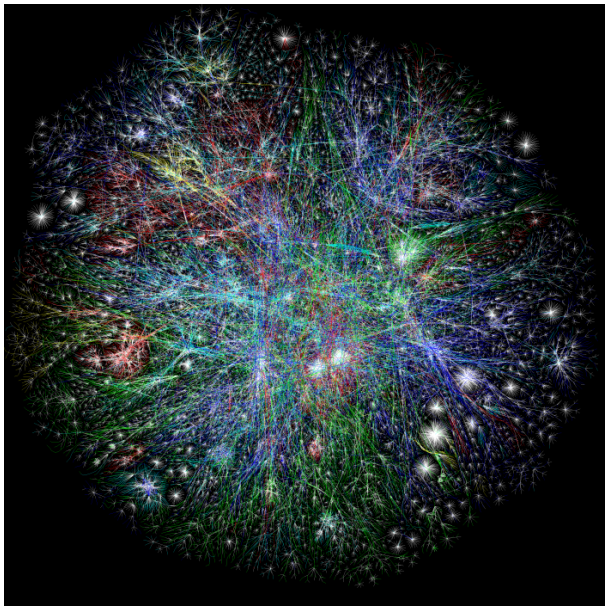


Figure 17: Barett Lyon, *The Opte Project* (2003). Map of global internet activity, colour coded to show links across IP addresses.

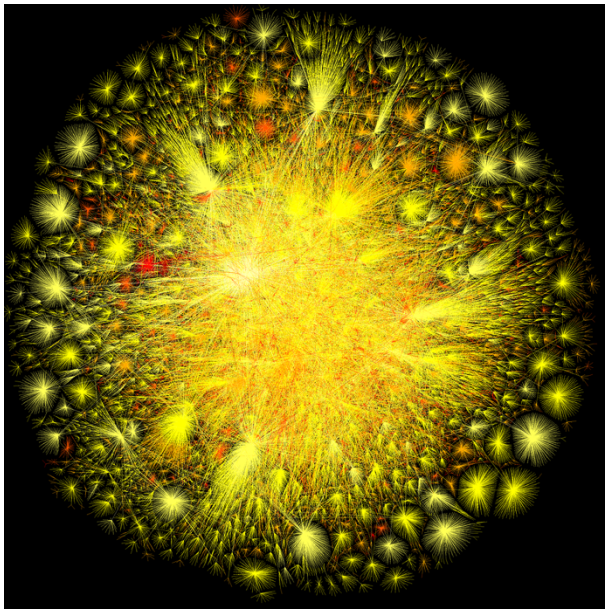


Figure 18: Barett Lyon, *The Opte Project* (2010), Map of global internet activity where the brightest lights indicate the greatest number of connection points.

The patterns found in nature are now contextualised in the contemporary 'digital environment'; the internet is described as a 'web', information goes 'viral', our emails are corrupted by 'bugs' and big data is stored in a 'cloud'. The significance of these trends is that contemporary representations of systems are increasingly focussed on the network as both a structural device and as a biological metaphor for the interconnectedness of life in the digital age. The dynamic nature of systems is acknowledged as a process that is in flux, 'self-organising' and capable of transformative 'emergent' behaviours. The human brain, hardwired as it is for pattern recognition has adapted and extended the metaphor of the 'tree of life' into a networked one that acknowledges a much higher degree of complexity and mutability.

The rhizome as a metaphor of connectedness

Cross-disciplinary complexity theory also allows for a philosophical interpretation of the network schematic. This has been most famously achieved through the concept of the rhizome, which was first introduced by Deleuze and Guattari in the opening chapter of *A Thousand Plateaus* (1987). In this work, they challenge the relevance of the tree metaphor as a universal structure for the classification of knowledge and instead champion the rhizomatic underground root structure of grass as more relevant schema. Deleuze and Guattari characterize the tree model as an arboreal hierarchy of organisation that grows through bifurcation and branching and is structured through binary opposition. As there is only one

pathway from the root to the tip of a branch, it is a vertically oriented and self-contained system that reinforces centralised control.

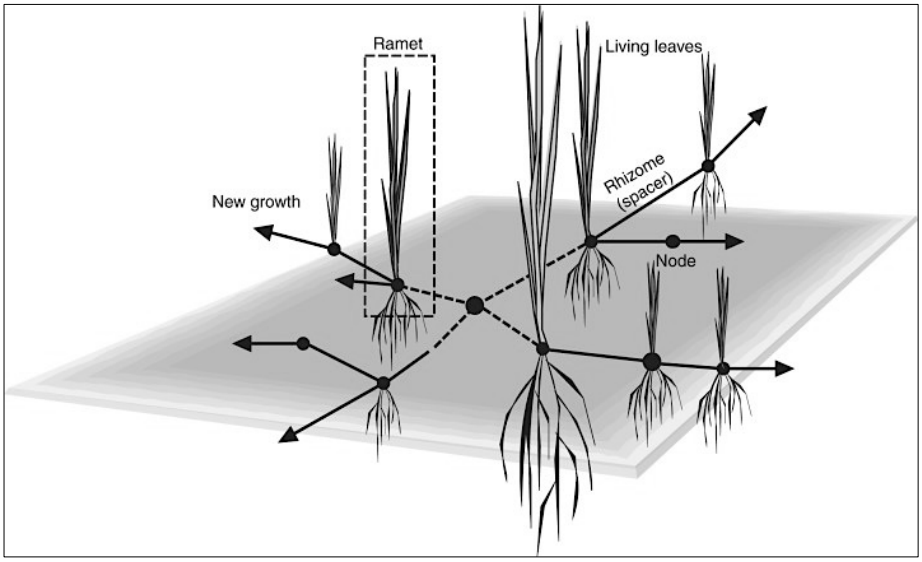


Figure 19: Diagram of grass showing clonal growth and rhizomes.

They contrast this with the rhizomatic system of growth that expands in all directions with no center, no starting point and no end. Unlike a branching model, it is a system without hierarchy or order as each point has the potential to be connected to all others. A rhizome continuously proliferates in all directions with no fixed boundaries and by its nature it is an infinitely expanding system: always in the middle, never complete and always moving. A characteristic of the botanical rhizome is that it can create multiple offshoots and each section can break away and create a new plant. Similarly, the rhizomatic model "operates by variation, expansion, conquest, capture, offshoots… (it is)… detachable, connectable, reversible, modifiable and has

multiple entryways and exits and its own lines of flight ” (Deleuze & Guattari 1987, p.21).

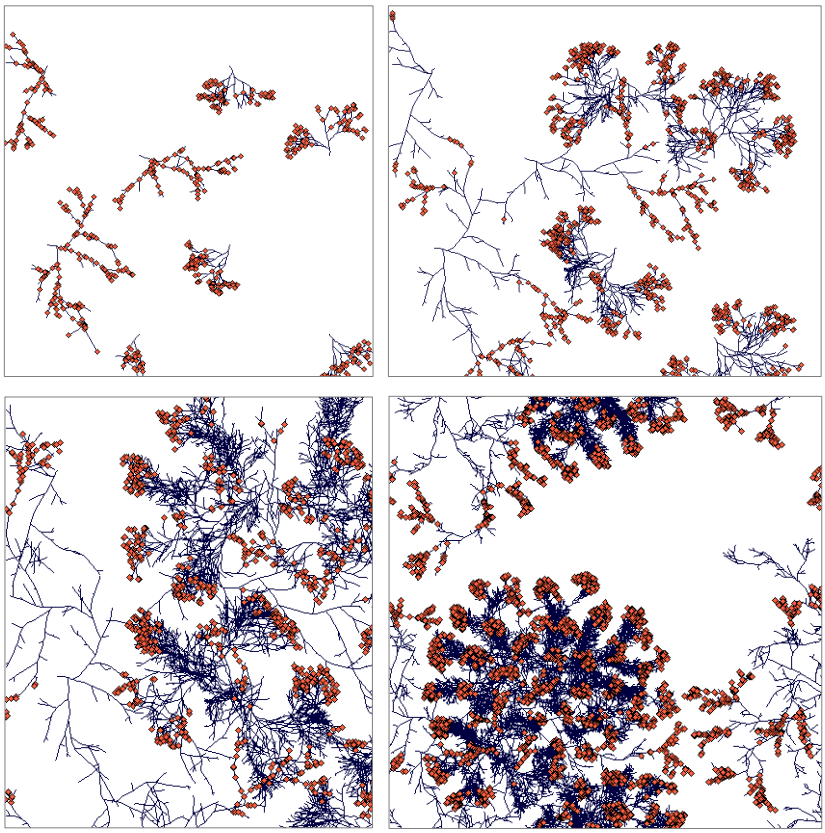


Figure 20 – 23, Computer generated models of rhizomatic plant growth, at 200 days (top left), 400 days (top right) , 700 days (bottom left) and 900 days (bottom right).

The rhizome and tree models are often misinterpreted as being in a binary opposition to each other. However, in Deleuze and Guattari’s theory, a rhizomatic and tree model can coexist and mark out different territories of thought, organisation and growth and in doing so become “rhizomorphic”. “To be rhizomorphous is to produce stems and filaments that seem to be roots, or better yet connect with them by penetrating the trunk, but put them to strange new uses” (1987 p.15). This broader term of rhizomorphic is useful in

conceptualising how the order and disorder inherent in all complex systems can be considered in terms of a dynamic mixture rather than an oppositional set of forces.

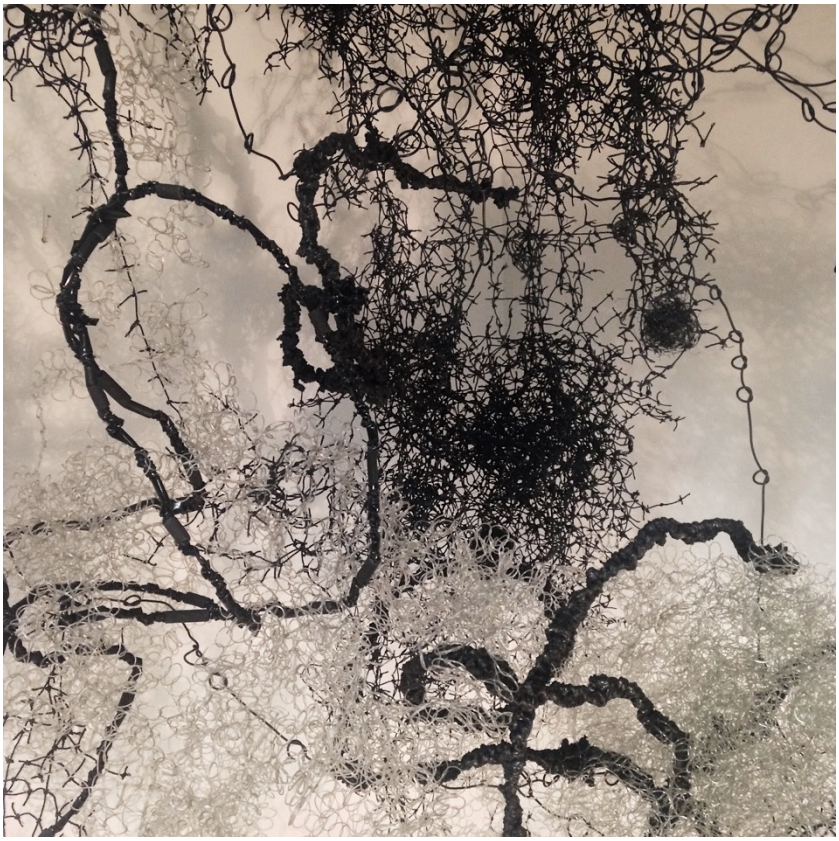


Figure 24: Linda Erceg, studio investigation, 2016.

Textile models of complexity

Deleuze and Guattari have also applied their concept of the rhizome to a way of understanding the patterning, organisation and boundaries of space. This 'technological model' is based on a textile metaphor that aligns the rhizome with 'smooth space' and the random entanglement of fibres that are enmeshed together to create felt. The arboreal structure of trees is aligned with 'striated

space' and the matrix of horizontal and vertical fibres used to construct woven fabric. They propose this model as a way of being in the world that challenges the dichotomy of inside and outside transcribed by bodily and geographic boundaries. They locate smooth space as the desert or the sea – a nomadic space that is constantly shifting and transforming and align it with the space of felted fabric as "infinite, open, and unlimited in every direction; it has neither top nor bottom nor center; it does not assign fixed and mobile elements but rather distributes a continuous variation" (1987, p.475). On the other hand, "woven fabric integrates the body and the outside into a closed space", the striated space of cities and sedentary organisation (1987, p.475).

Of particular interest to my project is the way in which the properties of fibre – as a singular line, an entangled mass, or a stitched structure - lends itself to a philosophical model that extends notions of physical and virtual connectedness. This dynamic model where "smooth space is constantly being translated, traversed into striated space; striated space is constantly being reversed, returned to a smooth space" (1987, p.474) can be seen in the stitching, folding, manipulation and unravelling of textiles.

This concept has also become central in the development of my studio methodology as I look for ways in which to physically enact the translation between smooth and striated space. In Chapter 3, I detail the processes by which the woven matrix of nets and meshes is disrupted and transformed into

branching structures with active, 'sticky' connective nodes. Released from their striated space, these fibres tangle into each other to create clumps and balls with varying degrees of stickiness that adhere to each other in the formation of much larger structures.

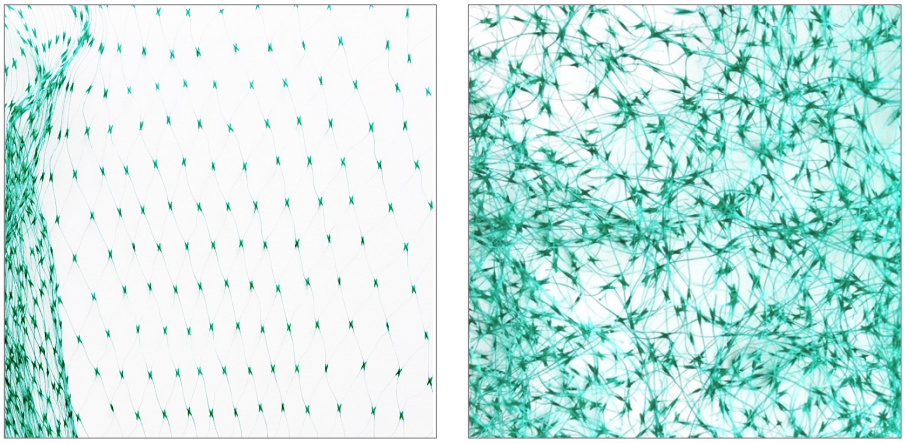


Figure 25 and 26: Linda Erceg, studio experiment, garden mesh – whole (left), cut and de-constructed (right).

Deleuze and Guattari (1987, p. 474 -476) discuss many forms of textiles as a mix between felt and woven fabric. "In knitting, for example, the needles produce a striated space; one of them plays the role of the warp, the other of the woof, but by turns. Crochet, on the other hand, draws an open space in all directions, a space that is prolongable in all directions – but still has a center" (1987, p. 476).

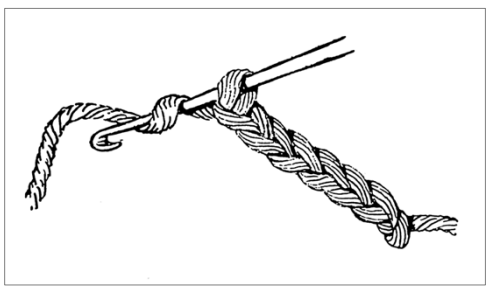


Figure 27: The looping action of crochet performed with one hook.

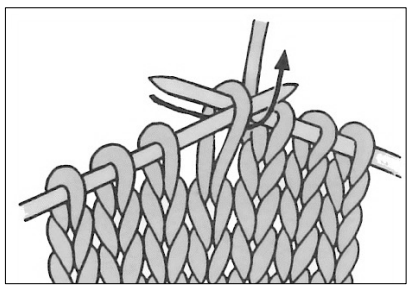


Figure 28: Knit stitches created by transferring loops between two needles.

This ability of crochet to create surfaces that can continuously expand and curve both inwards and away from itself can be used to create spatial and structural models that exemplify a complexity of foldings and interconnections. This theory has been tested in a number of projects where complex mathematical systems have been actualised as crochet models. Most significantly, this includes the work of Mathematician Daina Taimina who translated the ruffled, exponentially expanding growth described by Hyperbolic geometry into stitched forms. Published on the cover of the mathematical journal *Intelligencer* in 2001, Taimina's crochet models became the starting point for the Hyperbolic Crochet Coral Reef Project created by Margaret and Barbara Wertheim. In Chapter 2, I discuss the way in which the Wertheim sisters collaborated with Taimina to adopt her model as the basis of their highly influential cross-disciplinary art project.

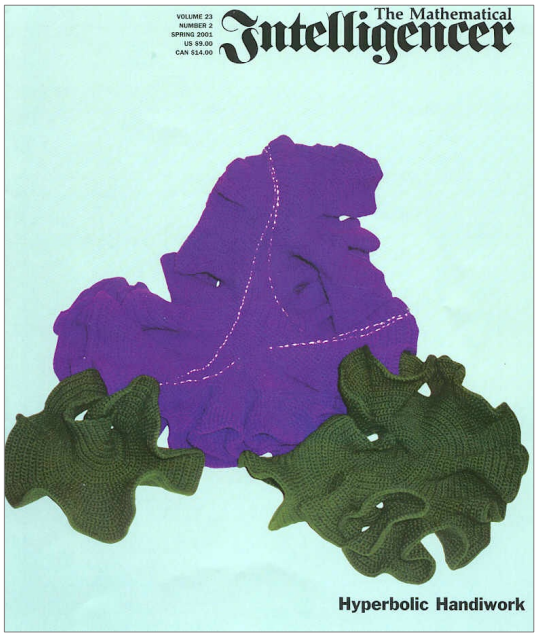


Figure 29: Hyperbolic Crochet forms by Daina Taimina, *The Mathematical Intelligencer*, 2001.

Summary

The concept of the rhizomorphic mixture has been central to the development of my studio research as it provides a model for hybrid and transformative patterns of growth. I repeatedly seek ways in which I can apply this theory through structural experiments that explore openness, fluidity and changeability. Like the rhizome, this approach creates a system with no beginning, middle or end. I document my various studio experiments and test installations in my search to materialise this theory in Chapter 3.

PART THREE: MATERIALITY AND MEANING

The cultural and ecological meanings of plastics

During this project, my studio exploration has increasingly focussed on plastics as the primary material of investigation. Having initially chosen plastics as a cheap and affordable way to make structural forms, its cultural and ecological significance has become a key factor in understanding the readings of my work. I have also considered the influence of my personal connection to plastic. As the cheerful and abundant material of my childhood play, it conjures up pleasant, nostalgic memories of toys in their varied shapes, colours and textures. I still find myself attracted to the benign innocence of its physical characteristics: its smoothness; lightness; translucence and vivid colouring.

Plastic is a fraught material, with a reputation that has shifted dramatically since the beginning of its industrial manufacture in the early twentieth century. Though it was initially developed to mimic expensive and precious natural materials such as wood, marble and gold through its ability to be coloured, textured and moulded, it quickly became clear that its uses would go far beyond this. Regarded with excitement and optimism, the spread of plastic materials through every part of consumer culture was considered to be capable of changing the way that people lived; delivering a cleaner, safer and more egalitarian future.

In 1941, chemist V.E. Yarsley described his vision of a plastic world that is chemically designed and devoid of the messy and unstable forces of nature:

> This creature of our imagination, this "Plastic Man," will come into a world of colour and bright shining surfaces. . . a new, brighter, cleaner, more beautiful world . . . a world in which man, like a magician, makes what he wants for almost every need . . . (Yarsley & Couzins 1941, p.149).

Published in 1957, Roland Barthes' essay on plastics, while having some reservations on its synthetic nature, gives a generally optimistic appraisal.

> So, more than a substance, plastic is the very idea of its infinite transformation; as its everyday name indicates, it is ubiquity made visible. And it is this, in fact, which makes it a miraculous substance: a miracle is always a sudden transformation of nature. Plastic remains impregnated throughout with this wonder: it is less a thing than the trace of a movement (Barthes 1957, p. 97).

Barthes' words have a prophetic truth to them, as the proliferation and spread of plastics has indeed started to transform nature. Unfortunately, plastics are not created miraculously, but are chemically synthesised from a combination of oil and natural gas obtained from fossil fuels. These materials are transformed into new compounds with long molecular chains and extremely strong chemical bonds. It is this aspect of their chemical composition that makes them extremely durable; a quality that produces astounding versatility as well as problematic

non-biodegradability. In the space of a hundred years, it has become impossible to ignore the fraught tension between the global ubiquity of plastics and the ecological destruction implicit in its production and disposal.

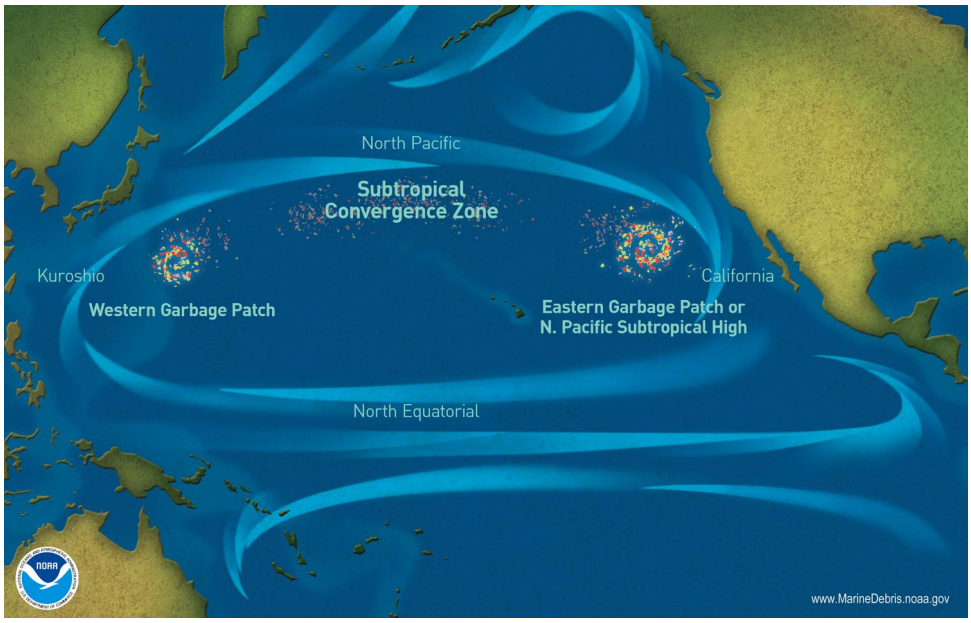


Figure 30: Great Pacific Garbage Patch, map by NOAA. (National Oceanic and Atmospheric Administration).

Since the mid 1980's, there has also been a growing awareness of how discarded plastics are forming accumulations in the ocean known as 'garbage patches'. The Indian Ocean, North Atlantic Ocean and North Pacific Ocean all have significant garbage patches that are created through the action of ocean gyres which are defined as "a large system of circular ocean currents formed by global wind patterns and forces created by Earth's rotation" (Turgeon 2014).

At the centre of the circular vortex of these ocean gyres is a stationary region of calm water into which the plastic debris drifts and accumulates. Tangling and

meshing together, some of these plastics are eventually dumped on beaches but most remain locked at sea forming a growing architecture of domestic and commercial refuse and cast-off fishing nets. Many of these plastics are degraded, weathered and eaten by birds and marine life that starve from ingesting the inedible material that remains inert in their digestive systems. The discarded nets become reanimated by the ocean currents and continue trapping and entangling fish and various other plastic debris in their new role as roving 'ghost nets'.

Figure 31: A discarded fishing net on the ocean floor, trapping organisms and other debris through 'ghost fishing'.

Many artists choose to create work that centres on the recognition that we have entered the age of the Anthropocene; a new geological era marked by the impact of human activity on the earth. In this context, plastic is seen to be 'Anthropogenic waste' and one of the material markers of human ecological

destruction in our contemporary geological timeline. While many plastics degrade with the effects of light, they never completely disintegrate. Instead they are broken down into smaller and smaller particles, with pieces smaller than one millimetre classified as 'microplastics'. These become suspended in the ocean, deposited in soil and sand, and absorbed by living organisms. This means that plastic never goes away; it is an immortal, 'undead' material that pervasively and intimately infiltrates all living systems.

In the first chapter of their book *Art in the Anthropocene* (2015), the editors Heather Davis and Etienne Turpin argue for the validity of art as a way of coming to terms with the contemporary ecological crisis. They claim that "the Anthropocene is primarily a sensorial phenomenon: the experience of living in an increasingly diminished and toxic world" (2015 p.3). They also acknowledge the opportunity that artists who work with these issues have to extrapolate from the scientific facts and create art that provides a new way of "thinking with and feeling through the Anthropocene" that goes beyond the alarmist and reactionary and engages with a deeper form of understanding (2015 p.3).

Fibre as a metaphor for living systems, connectivity and the body

Plastic, in the form of pliable fibres, has been central to my project as I have explored ways in which to manipulate various lengths, densities and textures into singular and connected forms. When exploring the metaphorical readings of my work, it has been essential to consider those associated with fibre. Many of these are related to organic growth and embodiment and I have investigated how these meanings can be understood and provoked through my artwork.

The simplest interpretation of fibre is through its linear quality and I have increasingly used this as a strategy for creating expressive gestures, marks, traces and connective paths. These in turn can also be seen to suggest pathways or markers of a physical journey over time. Fluid threads of scent, hormones and bodily excretions can be identified in the natural world in the silvery mucous trails of snails, the silken, sticky threads of spiders and the invisible pheromone trails of ants. These are used to mark territory, aid movement, trap prey and communicate passageways, creating a map of physical presence that connects to something important – food, home and safety.

A single thread, when interwoven with other threads or looped and knotted in on itself, creates a structural web that prompts metaphors of connection, wholeness and strength. The structures that I have created using the crochet stitch are all patterned with a 'holey' porous surface of interlinked loops. Displaying various degrees of elasticity, flexibility and rigidity, these forms

explore the tension between stitch and hole: transparency and porous exchange. In doing so, they evoke various textile metaphors that are associated both with containment and connection as well as isolation and separation.

Figure 32: Linda Erceg, Detail of installation test: *Growth System 2*

A 'holey' mesh, sieve or screen can act as a threshold or barrier that keeps some things in and others out. It can also act as a warning that marks a dangerous boundary or become a trap that lures and ensnares. In the natural world, the lacy, light mesh of spider webs are suspended in the air, creating a barely perceptible threshold that also captures insect prey. The visual and tactile delicacy of both spider webs and stitched lace is challenged by their surprising strength, elasticity and complexity. This quality of presence and absence is reflected in the naming of one of the earliest techniques of lacemaking as 'punto in aria', meaning 'a stitch in air' (Connor 2004, p.265).

The cellular and ordered nature of organic systems is echoed in the incremental nature of textile production. In the process of knitting or crochet, one stitch is added to the next and the resulting rows of stitches are used to 'grow' the fabric. Being easy to pick up and continue at any point, this form of hand-made stitching means that the potential for exponential growth in any direction is only limited by the amount of time and physical labour that is available for its production. The process of knitting or crochet creates a fabric from fibre by pulling loops through other loops resulting in a series of stitches and holes. It activates a single line through the gesture of the loop - where the end is connected to the beginning. Unlike the fixed loops of knotted or woven textiles, fabric made using crochet or knitting can be unravelled back to the original fibre by just releasing the final stitch.

Fibres can also be manipulated by being twisted (plyed together), stretched, pulled, made taut or slack, unravelled, frayed and cut. Fibre also lends itself to bodily analogies in the coiling, looping formations that threads of organic and synthetic materials readily assume. It is not surprising to find references to fibre in anatomical terms such as "*strand, tissue, membrane,* and *filament",* or that "biologists have also described nucleic acids as 'strings', 'strands', or 'threads' that 'coil', 'unspool', 'knit' and 'knot'" (Roosth 2012, p.11). Recalling the stringy mass of blood vessels and intestinal tubing that is tightly packed inside the body, a messy coil of fibre can evoke the alarming image of a body that is ruptured or eviscerated.

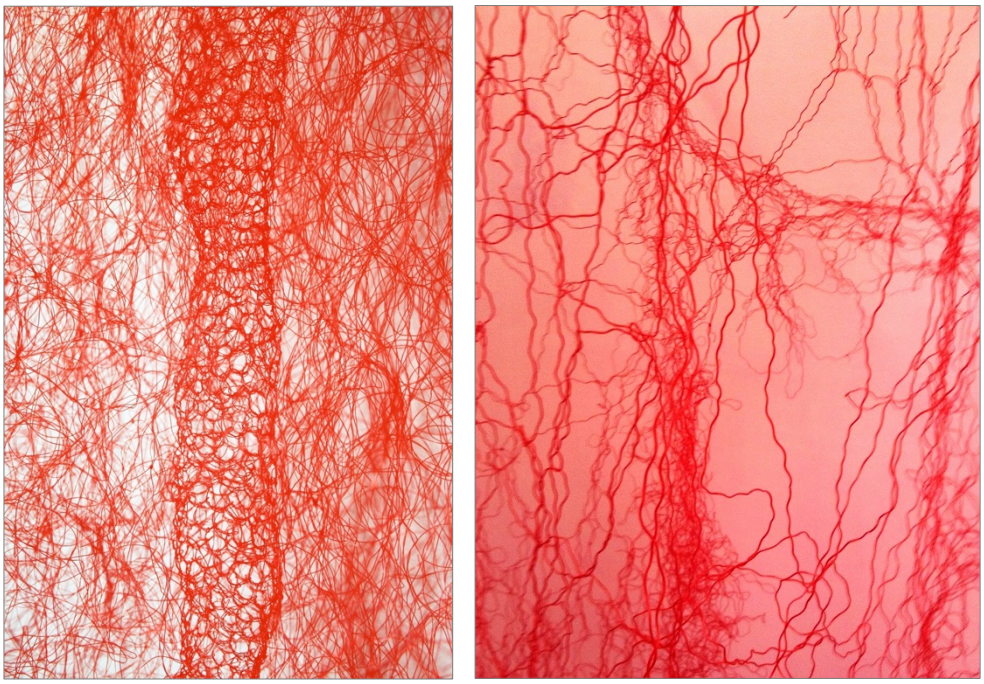


Figure 33 & 34, Linda Erceg, Details from test installation: *Biomorph Red*

The ability of thread and fibre to create soft and pliable shapes such as tubes, vessels, nets, veils, pouches and other biomorphic forms, lends itself to visualising bodily abstractions. These metaphorical perceptions are further enhanced by the ability of fibrous materials to physically evoke what it feels like to have a body; to occupy space and respond to gravity. Stitched fibres can suggest the sensation of drooping and wobbly body parts or the engorged and extended tube of the intestine. Various states of sensorial being can be evoked from pleasurable to painful; supple pouches can evoke inner organs that are turgid and painfully distended or flaccid and hollow.

The process of stitching fibres can also evoke the manipulation of a skin, with surfaces that can be characterised as inside or outside and front or back. They both share the ability of being transformed through physical manipulation and can change size through being stretched and expanded or shrunken and compressed. They are flexible and malleable and can be pleated, puckered and folded. Like the skin, stitched forms wrap and protect the internal spaces that they contain. Being enfolded can be very reassuring as it confirms the boundaries of the self through another layer or barrier to the world, providing privacy and an opportunity to hide or disguise parts of the self.

Figure 35: Insect cocoon with 'hair net'.

Figure 36: Linda Erceg, Detail from test installation: *Biomorph Yellow.*

In nature, the cocoon and chrysalis spun by the moth and butterfly larva, provide a mysterious container for the metamorphosis of the creature from larva to pupa and finally adult. This dramatic transformation culminates in the adult insect

tearing through and escaping from the sheltering cocoon in order to begin the last phase of its life. Given the ubiquity of insect cocoons, the form of a woven pod-like structure can also be interpreted as having similar meanings; suggesting a site of temporary retreat or transformative change.

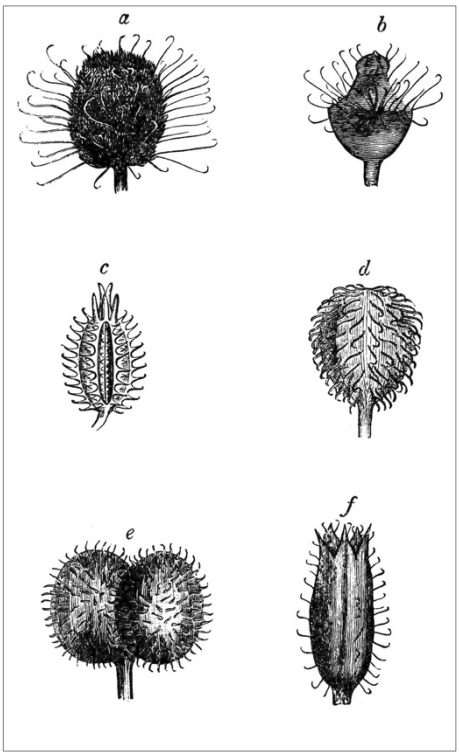


Figure 37: Illustration of various fruit seeds.

Figure 38: Linda Erceg, Detail from test installation – *Biomorph Yellow*.

In the botanical world, the seedpod is the site of fecundity, transformation and potential growth. Though generally spherical in shape, seedpods often have other unique features that aid in their dispersal from the adult tree. This includes a range of sticky filaments, burs, buds or bristles to attach to animals and delicate winged and parachute structures for travelling through the air. As a

symbol of fecund propagation, the seed can be an object of hope and also of dread. Being mobile, a 'bad seed' can spread to where it is not wanted and can proliferate into unruly growth. Likewise, stitched forms have the capacity to hide and disguise and can be used to trick and conceal identity.

The tension between order and collapse

Any system that grows and expands has the potential to do the opposite: break down, collapse and cease to exist. There are also patterns of unwanted growth; that which is malignant, cancerous and threatening to the system. Not all growth is healthy and a system can become an unwilling host to an opportunistic parasite. When this happens, the rules of growth are interrupted by the rules of disease, decay and disintegration and a new tension is created between the system and its breakdown. As the structure fails, the geometric and symmetrical qualities of the system collapse even further into irregularity, fragmentation and 'organic messiness'.

The Macquarie Dictionary defines an organism as "any structure the parts of which function not only in terms of one another, but also in terms of the whole" (1981 p.1202). Our bodies are our primary referent for understanding the complex nature of a functioning organism and by extension, the dynamic tension between order and disorder that is constantly being managed within it. In a very physical sense we are aware of the vulnerability of organisms through our

awareness of this push and pull in our own biological systems. This awareness can also be seen to prompt our fears and anxieties about 'wholeness' and a physical or psychological loss of control. However, as porous and permeable organisms, we are constantly ingesting and expelling the materials of the outside world. Our many sites of bodily entry and exit mark thresholds that can be considered simultaneously as sites of functionality, stimulation and contamination.

Joanne Turney, in her book *The Culture of Knitting,* uses Lacan's theory of 'lack' to identify the porous surfaces of living skin and stitched textiles as sites of incompleteness and fragmentation: "the rim, the ruptures that signify frailty and vulnerability through potential penetration" (2009 p.111). Turney describes how Lacan's theory of 'lack' results from the 'mirror stage' of development where the child distinguishes between the mirror image as intact, whole and perfect and themselves as imperfect, separate and lacking. As Turney writes:

> Individuals are constantly looking to make themselves whole and resolve the fragmentation that is returned to as a memory of the mirror stage. In Lacanian terms, bodies are the threshold – the boundary between the real and the desired self, the actual and the imaginary, the interior and the exterior… The fluidity of the boundaries created by textiles and the body itself are, in Lacanian thought, merely illusory surfaces that attempt to protect or appear to make whole that which never can be (2009 p.111).

Figure 39: Linda Erceg, Detail from test installation: *Biomorph Red*.

Julia Kristeva used the term 'abjection' in order to interpret the feelings prompted by unstable body boundaries and our efforts to control the leaking, chaotic messiness of life. "The abject is the acknowledgement of a boundary between life and death, between cleanliness and the improper or unclean, and it is constantly undergoing a process of repulsion and expulsion" (Turney 2009, p.120). The death of a living organism brings about a process of transformation as the structural order and integrity of the complex system is finally tipped into the side of chaos and disorder. The body loses form, shape and containment as the boundaries separating inside and outside collapse into each other.

These qualities of corporeal decay can also be interpreted through Bataille's notion of the 'informe', or 'formless', which he describes as "a term that serves

to bring things down in the world, generally requiring that each thing have its form" (Bataille 1929, p.382). The concept of formlessness gives value to chaotic, transitional and ambiguous forms that are often seen in the degradation and entropy of matter. It sees messiness not as a state of vulnerability but as a state of infinite possibility.

Figure 40: Linda Erceg, Detail from test installation – *Growth System 2.*

Figure 41: Linda Erceg, Components after the de-installation of *Growth System 2.*

This view is supported by the work of Mary Douglas, particularly where she identifies the cultural value of order and the transitional power that is generated from its disruption. She claims:

> Granted that disorder spoils pattern, it also provides the materials of pattern. Order implies restriction; from all possible materials, a limited selection has been made and from all possible relations a limited set has

> been used. So, disorder by implication is unlimited, no pattern has been realised in it, but its potential for patterning is infinite. This is why, though we seek to create order, we do not simply condemn disorder. We recognise that it is destructive to existing patterns; but also that it has potentiality. It symbolises both danger and power (1966, p.117).

This proposition identifies the risk and transformative potential inherent in any process that embraces the force of chaos. This includes the cyclical processes of life and death which are culturally perceived as threatening and damaging. They are however, essential for the natural order and balance of living systems. A state of entropic chaos can also result in new generative possibilities: surprises, variations, beneficial adaptations, hybrids and mutations. It finds a visual metaphor in the structural qualities of textiles, which are capable of containment, flexibility and porous exchange as well as rupture, disintegration and collapse.

Summary

The processes of undoing or unravelling my stitched forms, collapses their structure into dangled, heaped or jumbled mounds. As they return to the pile of plastic line or nylon rope that was their starting point they retain the crimped kinks of their previously stitched state while also holding infinite potential for new configurations. This malleability of plastic fibre makes it suited to both holding the patterns that order living systems and also to responding to the effects of messy, chaotic deterioration. It shows the tension between these two

states as a place that is charged with transformative potential. It is an analogy that is complicated by the fact that while plastics grow and proliferate in the environment, they also resist final decay, which is the ultimate fate of all living organisms. Plastics are revealed as the resilient, adaptable, 'undead' colonisers of the contemporary world.

In the next chapter I will discuss how my project has been contextualised with the work of selected contemporary artists. I draw on the concepts discussed in my central argument and show how these artists have explored and interpreted these ideas in the resolution of their artworks.

CHAPTER TWO: CONTEXT

INTRODUCTION

My project is informed and contextualised by the work of contemporary artists who explore the images and ideas of growth. While many of these artists use fibres, plastics and textile processes in their work, I have not limited my investigation exclusively based on material. I am particularly interested in the way in which patterns emerge as forms are created, as well as the various meanings and associations that these structures provoke. The artists that I will discuss include: Ruth Asawa; Tara Donovan; Margaret and Christine Wertheim; Eva Hesse; Ernesto Neto and Lucy Irvine.

PART ONE: INVESTIGATING STRUCTURAL MORPHOLOGIES

Ruth Asawa, Margaret and Christine Wertheim and Tara Donovan, all produce sculptural works through the application of rules and iterative repetition. While they may reference scientific and mathematical theories and processes, they interpret rather than imitate the generative possibilities of biological modelling of pattern. Their approach to form creation is driven by a process of rule setting that is deeply informed by an understanding of material properties, achieved through extensive testing and manipulation of their chosen materials. The organic forms that result from these processes become part of an evolving morphology that is extended and developed through successive works. Also embracing the fallibility of evolutionary systems, they recognise that mistakes

evoke natural forms more strongly than mechanical reproduction and can result in surprising anomalies.

Ruth Asawa: Fluid boundaries and transparent forms

Ruth Asawa's wire sculptures resemble organic forms with iterated variations on a few structural themes. Stripped of embellishment or any colour other than that of the wire, the two strategies used - either looping or dividing - become the focus of the work. Her sculptures are the result of two techniques: crochet to create structures made of repeated, interlocking loops and dividing bundles of wire into tied and bifurcated branching systems. Of interest to me is how her methodological approach to rule setting (determining process, technique and material) is linked to the key features of her work: transparency, fluid boundaries between inside and outside and the use of shadows in situating the work in a space.

Asawa is most well-known for the pendulous and lobed forms that she made during the 1950's and 1960's, all of which are 'Untitled' and sequentially numbered. She created these sculptures using the technique of the repeated single crochet loop, which she adapted from her knowledge of wire basket making. Asawa described her process in the following way:

> The crochet loop is like an e. You begin by looping a wire around a wooden dowel, then making a string of e's, always making the same e loop. You can make different size loops depending upon the weight of the

wire and the size of the dowel. You can loop tight and narrow or more open and loose … All my wire sculptures are made from the same loop. And there's only one way to do it. The idea is to do it simply, and you end up with a shape. That shape comes out from working with the wire (Cornell 2006, p.16).

Figure 42: Ruth Asawa, *Untitled (S.267),* detail, 1952.

Figure 43: Ruth Asawa, *Untitled (S.080),* 1950

When speaking of this series, Asawa has stated: "What I was excited by was I could make a shape that was inside and outside at the same time… you could create something that just continuously reverses itself" (Cornell 2006, p.16). She constructed these works from a continuous length of wire to create segmented and interlinked forms where the interior and exterior are inseparable from one another; like the membranes and skin of an organism that folds in and over itself. Asawa called this technique "form within a form" and she used it to manipulate a

single length of wire into a crochet surface that progresses from inside a sphere to outside and back inside again, in a fluid undulation where the inner lobes are suspended and contained by the external layers.

Figure 44: Ruth Asawa, Installation detail from the exhibition *Architecture of Life*, Berkley Art Museum.

Asawa's work demonstrates a dedication to self-imposed rules in order to create a focussed approach to technique, process and materials. It also reflects her college studies and the teachings of Joseph Albers whose modernist approach to 'truth to materials' is revealed in her belief that "each material has a nature of its own" (Cornell 2006, p.41). By working within these limits, she could explore the way in which her process could reveal the 'personality' of wire in a way which did not change it and which was reversible. She was successful in achieving this equilibrium in her sculptures; "While essentially a line, through manipulation

they become volumetric, yet they retain their essential line-ness: they could easily be unwound and returned to their initial state" (Cornell 2006, p.41). Asawa also acknowledged that she was drawn to the reassuring and familiar aspects of natural processes and that her way of working was a way of allowing things to grow naturally.

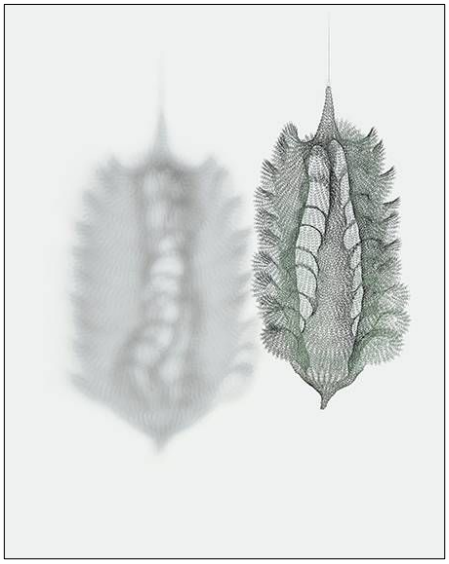


Figure 45: Ruth Asawa, *Untitled (S.210),* 1958.

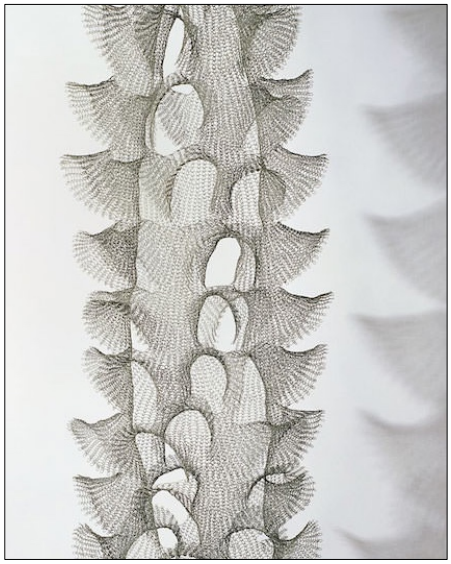


Figure 46: Ruth Asawa, *Untitled (S.039),* detail, 1959.

Though not motivated to create identifiable elements from nature, by setting herself the rule of creating spherical shapes that reversed in on themselves, she was mimicking a process of form creation that is recognisable in nature. Her sculptures become suggestive of the inner chamber of shells, multi layered seedpods, microscopic organelles or translucent floating organisms. They also become metaphorically charged as forms that are simultaneously protected and enclosing as well as being permeable and transparent.

Asawa created another series of 'Untitled' works during the 1950's and 60's for which she used the technique of tying, dividing and branching. Starting with a bundle of wire, which could contain a few hundred through to a thousand loose pieces, she would tie these into a central stalk and then methodically separate and tie branching divisions from either end. Asawa said of her process; "Once you have tied the centre, you have made a decision…The wires contained in the central stalk determine the number of branches or roots that can be separated out from either end" (Cornell 2006, p.22).

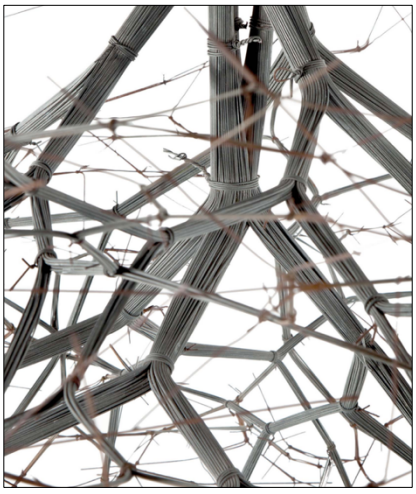


Figure 47 & 48: Ruth Asawa, *Untitled (S.202)*, left – detail, 1962.

Unlike the crochet lobed forms, Asawa ascribes a direct reference to nature when discussing the methodology and motivation for this work. She cites a failed attempt at drawing a desert plant with a complex branching design as prompting her to mimic the process of repeated division with wire. This experiment helped her to understand the structure that she was trying to draw and also resulted in a number of sculptures that explore the process of bifurcated division. While

these structures most closely resemble the branching of trees and roots, sprays of foliage and root balls, some also recall dendrites and molecular models. Using a variety of thicknesses of wire, Asawa achieved a level of density and detail in these structures that oscillates between ordered branches and those that become tangled, fuzzy and fragmented. While some of these forms become soft and less defined at their perimeter, many remain spiky and potentially dangerous with exposed wire ends bristling from their central core.

Figure 49: Ruth Asawa, Detail of permanent installation at de Young Museum, San Francisco.

When installed, Asawa's sculptures are hung from the ceiling in clusters and groupings, where the transparency of the forms enables several to be seen in

new and overlapping configurations. The most significant transformation achieved through installation of these works is through the lighting, where the open lattice of the structures creates a patterning of shadows on the walls, floor and ceiling of the space.

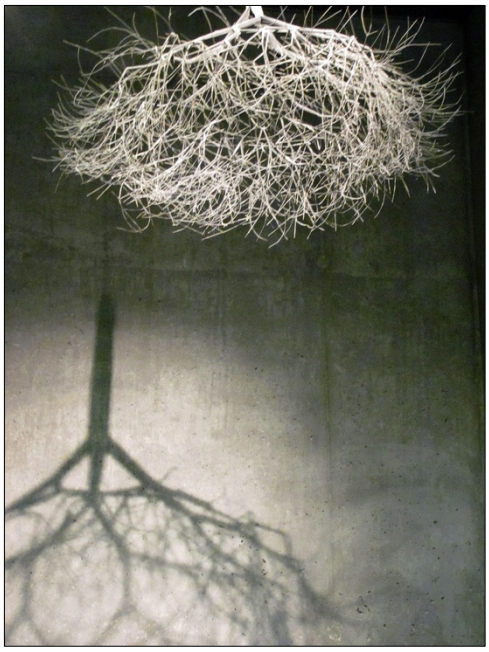


Figure 50: Ruth Asawa, Detail of permanent installation at de Young Museum, San Francisco.

These shadows amplify the forms by echoing them at a much larger scale where the intricacies of the repeated crochet loops and branching spikes are expanded and multiplied. This is particularly evident in the permanent installation of Asawa's work at the de Young Museum, where various large lobed and frilled forms are brought together with much smaller branched sculptures. As negative and positive are reversed, some of the forms become far more substantial and volumetric as cast shadows. One space is dominated by multiple shadows of a large uprooted tree, which is in fact projected from a small, branched sculpture.

The overall effect for the viewer is an atmospheric and immersive space achieved through the interplay of tangible and ghostly organic structures.

When Asawa's work is viewed individually, her singular forms are minimal, abstract and contained. However, when grouped together and lit to reveal shadows, the subtle and nuanced differences between her various structures are amplified and mysteriously transformed. These installation strategies allow her work to extend beyond a purely structural reading and become an experiential and transformative space.

Margaret and Christine Wertheim: Evolutionary morphologies

Focussing on wool and plastic rather than wire, Christine and Margaret Wertheim build organic structures through the accumulation of individual crochet forms to create the *Hyperbolic Crochet Coral Reef.* Since the mid 1990's, with the rise of on-line craft communities, the connection between computational thinking and needlework has received considerable attention. Recognising the shared iterative and algorithmic nature of the processes used to create computer code and knitting and crochet patterns has prompted a diverse range of interdisciplinary projects that have been shared in on-line platforms. Beginning in 2005 and still active in 2017, the *Hyperbolic Crochet Coral Reef* created and curated by the Wertheim sisters is the most successful of these.

With professional backgrounds in science and art, the sisters found inspiration for this project when they discovered the work of mathematician Daina Taimina. Taimina's transformation of an abstract model of hyperbolic geometry into a physical crochet model prompted the Wertheim sisters to adopt and elaborate on her techniques. Over a period of two years, the sisters experimented with crochet hyperbolic forms and began to deviate from the strict rules that determine mathematical accuracy. Margaret Wertheim describes how "Christine came home one day with a big bag of fluffy wools – pink and orange hairy things – and she said, 'I'm really sick of crocheting perfectly mathematical ones. I'm branching out'… She started making aberrations, mutating the pattern, and the pieces immediately started to look organic, like living things" (Tanguy 2014, p.39).

Figure 51: A large, symmetrical hyperbolic plane by Daina Taimina.

Figure 52: Marianne Midelburg, Margaret and Christine Wertheim, *Crochet Coral and Anemone Garden with Sea Slug*.

An accumulation of these crochet forms led the sisters to make a connection with the growth of coral reefs, which are also composed of repeated hyperbolic structures. They then used this model to develop an experimental and evolving

taxonomy of reef-like forms by distributing the project in an on-line platform. In the space of the last twelve years, this project has been shared with other participants to create a worldwide art project of satellite reefs, evolving new forms with each exhibition. The participants in the project bring their own interpretation of the rules of growth as well as experimenting with materials, tools and scalability of the forms. Of interest to my project is the way in which the iterative process of growth, mutation and evolution are explored both at the individual level by the participants and also by the Wertheims as curators of the reef installations.

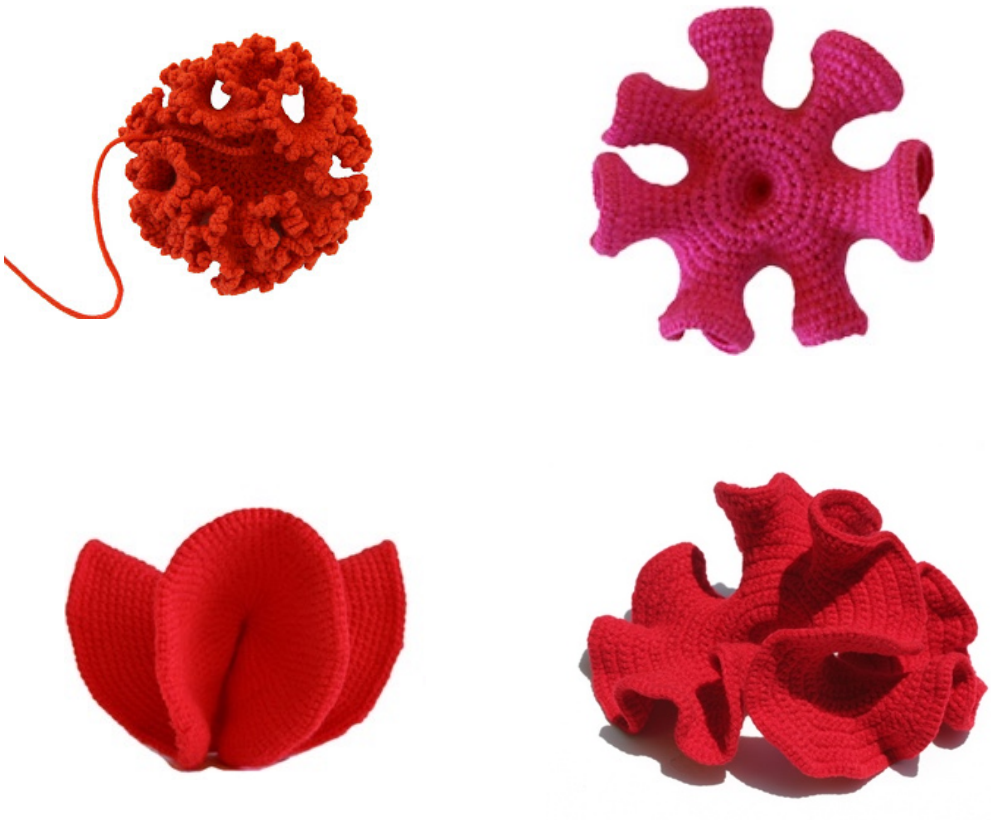


Figure 53 – 56, Crochet hyperbolic forms by Anita Menning, Margaret Werthem and Daina Taimina.

The starting point for all of the project participants is the basic rule for hyperbolic growth, which requires a regular increase of stitches from one row to the next in order to produce a surface with a ruffled edge. As rows are crocheted, the growth is exponential and dependent on the ratio that is used for the increases. For example, if the original row is 10 stitches, by applying a ratio of 1:2, the second row will contain 20 stitches, the 3rd row will contain 40 stitches, the 4th row 80 stitches and the 5^{th} row will have 160 stitches. Following the hyperbolic rules of growth, the circumference of a structure increases very rapidly and the process of stitching the model gives a physical sense of how quickly the shape expands and starts to fold in on itself. As Margaret Wertheim observes: “The first rows take no time but the later rows can take literally hours, they have so many stitches. You get a visceral sense of what “hyperbolic” really means” (Roosth 2012, p.20).

Using a range of materials such as: wool yarns; plastic; wire; videotape and shredded shopping bags, the project participants often begin with a stitch perfect rendition of the hyperbolic algorithm. Experimenting with the ratio, a larger or smaller number of ruffles can be produced and when this is combined with unusual and often ungainly materials, other variations and deviations can occur. The labour of making the model can become tiresome and shortcuts can lead to mistakes, skipped stitches, abandonment of rules and a change of direction. Again, the Wertheims found that the more experimental the crocheters were, the more organic the reef became. Reflecting on this

observation, they drew parallels with the process of natural evolution where "there's an algorithm at the heart of everything. Life forms start with a simple code, and the DNA gets more diverse as time goes on. Life never leads, however, to perfection: you don't ever see a perfect sphere in nature. You don't see perfect hyperbolic spheres, either" (Karafin 2008, p.221).

Figure 57: Margaret Wertheim, in the *Föhr Reef*, Museum Kunst der Westküste. Föhr, Germany, 2012.

When viewing images of the exhibited hyperbolic reefs, it is very clear that a large amount of strategic planning is required for the curation of this vast and eclectic mass of objects. Individual forms are stretched over vertical supports, clumped together to create 'reef balls', suspended in hanging clusters and piled onto low plinths that snake around the exhibition space. There are the recognizable ruffled hyperbolic spheres and fronds, which in the context of a 'reef' suggest corals, sea slugs, sponges and bull kelp. However, there are also a

large number of forms that are clearly not using the original algorithm such as: tubes; pods; balls; bulbs and spirals. A key factor to the Wertheims' curatorial strengths is how they take this eclectic combination of forms, and through situating aesthetically pleasing structures with those that appear irregular or misshapen, validate the individuality of the eccentric and aberrant.

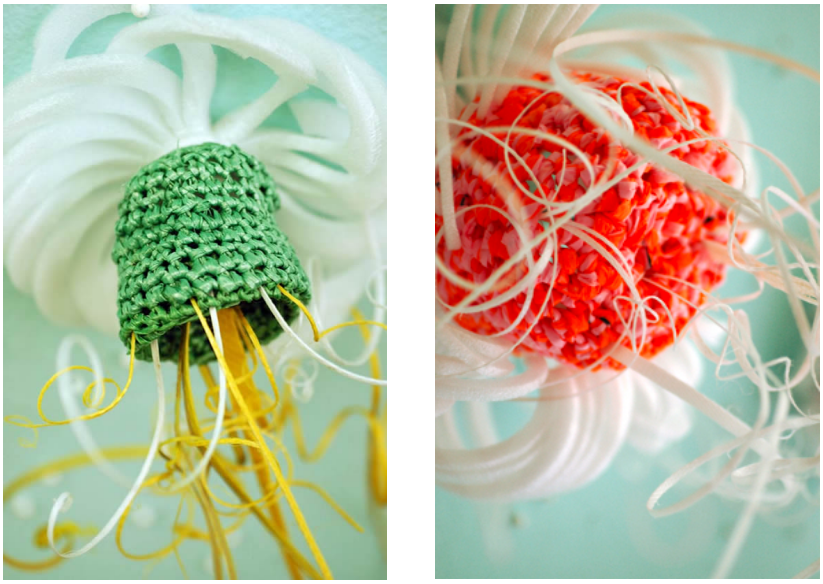


Figure 58 - 59: Inga Hamilton, *Wall Swarm* (detail - left), *Plastic Bag Anemones* (detail – right), *Chicago Coral Reef*, Chicago Cultural Centre, 2007.

One of the few on-going installations that has been exhibited numerous times is *The Toxic Reef*, which is a large sub-reef made largely from plastic, with a focus on recycled and discarded items. This ensemble of forms reveals the greatest deviation from the rules of the hyperbolic model as it also incorporates the most diverse mix of materials. This includes: cable ties; polystyrene pellets; plastic bottles and cups; marine rope; plastic strapping; ping pong balls; industrial safety ribbon; plastic bags; plastic coated electrical wire; video tape and fruit nets. As

many of these materials cannot be easily shredded into yarn for crochet, they introduce other shapes, densities and volumes into the overall 'reef' taxonomy.

Figure 60: Margaret Wertheim, *Bin-Liner Jelly Fish Flock (detail).*

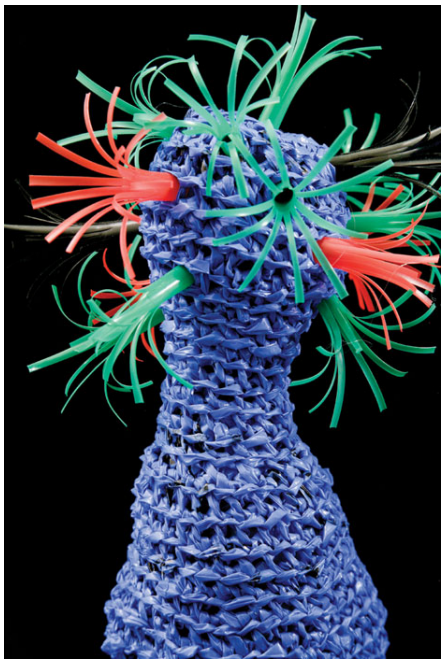


Figure 61: Clare O'Callaghan, *The Blue Grove*.

The *Toxic Reef* also highlights the participants' ingenuity with unlikely and often ungainly materials, with some forms achieving a surprising beauty and fragility while others are decidedly clumsy and awkward. Not wanting to disguise the origins of their recycled plastics, many of these participants have found economical means to create their forms, which gives them a unique simplicity and directness. Often working with saturated primary colours, soft pliable textures and surfaces that can be cut and manipulated, the attractive and repellent qualities of these plastics are brought together in unexpected juxtapositions. As ongoing works, *The Trash Vortex* and various satellite *Plastic*

Reefs demonstrate the malleability and transformative potential of recycled plastics through their evolving, eclectic and unpredictable morphologies.

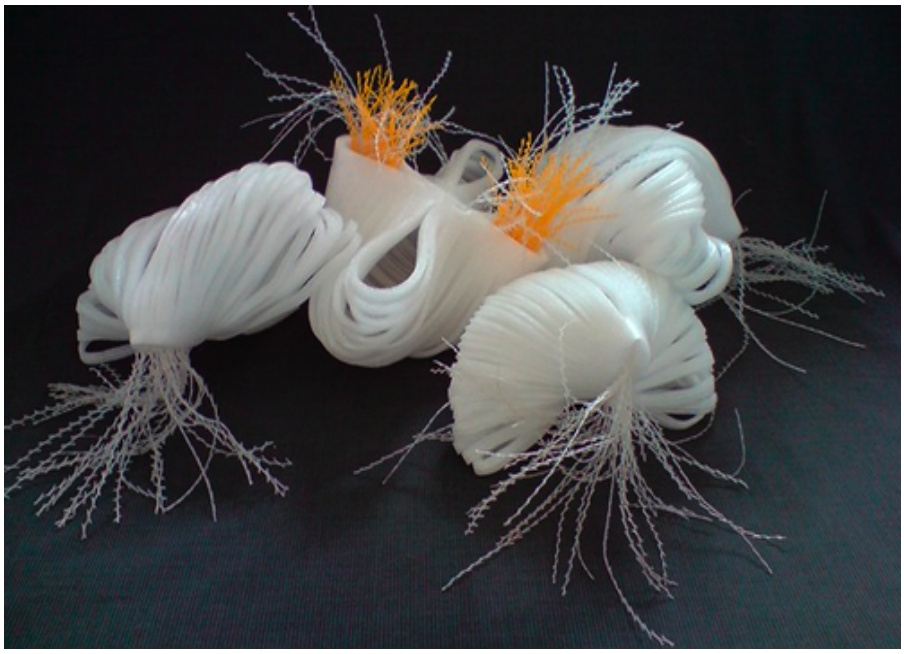


Figure 62: Inga Hamilton, *White Feeding Forms, Chicago Coral Reef,* Chicago Cultural Centre, 2007.

One of the key insights gained from researching the *Hyperbolic Crochet Reef* project is the value of chance discoveries, accidents and new directions. This project demonstrates how adhering too rigidly to a set of rules can result in the production of forms that are mechanically predictable, regular, symmetrical and 'correct'. On the other hand, it also shows how letting go of control can produce unexpected variation, much like the processes of natural selection where mutation, aberration and irregularity take their own course.

Tara Donovan: The natural order of things

Tara Donovan also works with large accumulations of matter in order to create installations that interpret the systems and processes of growth. Her immersive and atmospheric environments are formed using massed commonplace and utilitarian objects such as: polystyrene cups; drinking straws; scotch tape or paper plates. While Donovan does not set out to imitate particular structures, by working with multiple components the resulting order and patterning often resembles natural forms such as molecules, cells, clouds, water or landscape topographies. For my project, I am interested in how her poetic analogies of growth are achieved through a methodology that relies on a strict economy of materials and process.

Figure 63: Tara Donovan, *Untitled (2003)*, detail view.

In order to make her work, Donovan orders vast quantities, sometimes millions of units, of a manufactured product. She then experiments with the material and creates rules by which to bring together an accumulation of one type of item with a minimum of intervention, allowing its inherent properties to be enhanced. Donovan says of her work:

> I'm using a material and assigning it predetermined rules. I'm relying on the 'strawness' of the straws, the fact that each one is a long hollow thing. Basically, I'm not employing any tricks. I'm letting it do what it naturally can do. Within these rules, the construction allows the work to grow, similar to the way in which living structures develop. Rules for growth are encoded within each individual element, and the work winds up appearing organic because the process mimics basic systems of growth (Chattopadhyay 2005, p.267).

Figure 64: Tara Donovan, *Untitled (2003)*.

In *Untitled (2003)*, the translucence of styrofoam cups becomes beautiful and intriguing when packed together and glued into a backlit, undulating and suspended installation. Resembling a cloud mass from a distance, on closer inspection, the individual spherical hollow forms suggest a more hive-like and mysterious space. In this example, as in all her work, Donovan chooses the least coloured version of a material. Over time this has included; translucent plastic drinking straws, clear acrylic rods and white polystyrene drinking cups. She states that this allows the fugitive colours, due to imperfections in the manufacture process and enhanced through the effects of light, to appear as a subtle trace throughout the work. This property creates a visual complexity that shifts with the viewing angle and adds to the transformative perception of the material as a natural form.

Donovan acknowledges that the success of her work lies in her own ability to recognise and respond to the uncanny flip between a stacked accumulation of objects and its visual transformation into a natural system. Experimenting in her studio, she manipulates and plays with a number of different materials – looking for the "one answer for each material" (Donovan, Baume, Mergel & Weschler 2008, p.9). Many of these discoveries rely on serendipity; through spilling a large box of toothpicks she found that friction caused the pieces of wood to adhere to each other, defy gravity and hold a shape. In Donovan's search for the 'one answer', she is testing how materials respond to the same laws of physics that create growth patterns in nature such as honeycomb, bubble foams and

crystalline structures. Her processes of accumulation and growth, which may include stacking, twisting, looping and clustering are tested in a small scale in her studio and then repeated by a team of assistants over several days or weeks to create an immersive installation. The boundaries of these works are often strategically constructed to create a sense that the forms have the potential to keep spreading – like an organic expansion or a viral infestation.

Figure 65: Tara Donovan, *Nebulous* (2002), detail view.

Nebulous (2002), is made from thousands of clear and frosted strips of scotch tape, looped into units that spiral, mound and spread across a floor. Donovan says of this work:

> The only thing that I'm using about the tape is its transparency and the fact that one side is sticky and you can make it stick to itself. Then, I basically make units, but once they're amassed and accumulated, it reads like fog. I'm not intentionally trying to mimic or make things that look like

> nature. I'm mimicking the processes of nature, so that the final form winds up reading as such a thing (Chattopadhyay 2005, p.269).

This installation can be interpreted as many things: "*Nebulous* appears almost like a mist concentrated over about twenty feet of floor. Its uneven shape suggesting either a blown-up view of microscopic mold or a scaled-down model of the Milky Way" (Donovan, Baume, Mergel & Weschler 2008, p.9).

Figure 66: Tara Donovan, *Nebulous* (2002).

In *Untitled (Mylar)* 2011, sheets of mylar plastic are folded into layered cones and glued together to create spherical globes of varying sizes. Made from 'metalised mylar', an aluminium coating gives the plastic sheets a distinctive mirrored finish. It also causes light to be reflected and absorbed into the forms, creating a complex interplay of deep shadow and glittery highlights which shifts as the viewer moves around the work.

Figure 67: Tara Donovan, *Untitled (Mylar),* 2011.

Clustered together and appearing to grow up and out of each other, the globes rise from the floor in aggregated branching clumps. Smaller forms grow out of larger ones, with the tallest peak reaching a height of eleven feet. The gigantic scale, fractal repetition of forms and irregular configuration all inflect this work with the dynamic physical presence of a 'growing form'. These factors also ensure that the attractive, glittery surfaces are radically transformed beyond their origins as decorative packaging. Suggesting a dark and ambiguous outcrop of coralline structures or the massed, hardened spores of an alien organism, this dense growth of globes reveals bright centres made of soft, pliable folds.

Figure 68: Tara Donovan, *Untitled (Mylar)*, detail, 2011.

Donovan rigorously tests and examines the way in which light affects and interacts with a material when developing her rules to create the 'one answer'. She achieves a dramatic result in *Untitled (Acrylic and Adhesive)*. In this work, large pompoms of acrylic rod are glued together to form a room-sized mass of glistening, clustered balls. Appearing soft and fluffy from a distance, on closer inspection the hard spikiness of their material truth is revealed. This heightened illusion of depth, volume and texture is enhanced by the way in which light is absorbed and reflected by the acrylic.

Figure 69 & 70: Tara Donovan, *Untitled (Acrylic and Adhesive)*, details, 2014.

Figure 71, Tara Donovan, *Untitled, (Acrylic and Adhesive)*, 2014.

In all of her work, Donovan develops rules of growth after intensive material experimentation which requires a high degree of sensitivity to physical properties: shape; texture; interconnectivity and malleability as well as to the effects of light: translucence; opacity; luminosity and reflectivity. She admits that many of her material tests and trials can remain unresolved for years with the 'one right solution' happening by accident or as the result of successive focussed attempts. Donovan's receptive and patient approach to material exploration demonstrates the importance of being open to chance and allowing the inherent structural properties of materials to take their own shapes. She has come to understand that the simpler and more direct the approach, the more surprising and authentic the transformation into the final installation.

The patterns of growth that Donovan achieves have been described as being "built in rhythms that are not ordered or predictable but are nonlinear, irregular and evocative of emergent expansion in which repetition implies replication, rules are self-generating codes, and material properties shift, and even reverse, when increased by orders of magnitude" (Donovan, Baume, Mergel & Weschler 2008, p.8). In doing so, she explores the tension between ordered and chaotic systems and creates processes and rules for visualising the patterns of organic expansion from the simple to the complex.

Summary

While creating artworks that are resolved in very different ways, Ruth Asawa, Margaret and Christine Wertheim and Tara Donovan, all share a common interest in the creation of form through the processes of repetition and variation. By applying predetermined rules of growth, they amass collections, accumulations and connected masses, where the individual elements become amplified and take on a new life. In each case, rule setting provides an important framework. However, they all acknowledge the role of chance and accident in the creation of forms that have the unpredictability and irregularity seen in nature. I have sought to apply these insights in relation to material investigation, form creation and installation strategies in my own studio methodology.

PART TWO: VULNERABLE SYSTEMS AND THE LANGUAGE OF MATERIALS

While also investigating forms and structures that result from iterative processes, Eva Hesse, Ernesto Neto and Lucy Irvine have focused on the metaphorical triggers that can be created with their chosen materials. This is achieved in their work through a variety of strategies including the subversion of the crafting process and the amplification of the material properties of various unconventional yarns, textiles and plastics. Through a rigorous process of experimentation, they have all focussed on signature materials that are explored for their structural and associative properties. Often examining metaphors of corporeality and connectivity, their work is open to readings on many levels. Through a discussion of selected works I will explore the key strategies that these artists use and the range of meanings that they evoke.

Eva Hesse: The emotional language of materials

Using a vocabulary of dangly, droopy, pendulous and ambiguous forms, Eva Hesse exploited the ability of her chosen materials to create structures that suggest the irregular patterns of natural growth. Shunning the precision and hard edges of Minimalism, while still adhering to highly disciplined processes, she validated the use of an extended palette of malleable, commonplace materials including: fiberglass roving; latex; rubber; wire; rope; cord and string. Of particular relevance for my project are a number of Hesse's works in which she

manipulated rope and other malleable materials to suggest both the physical and psychological vulnerability of embodiment.

Hesse often stated that she was seeking the 'wrong' solution over the 'right' one in an attempt to challenge expectations and avoid decorative effects in her work. Although she often used materials favoured by the 1960's homespun aesthetic such as rope, jute and string, there was nothing comforting or rustic in her treatment of them. Her fibres were dyed and stiffened to become tough, spikey and stiff, or encased in thick, clotted layers of latex and resin. When she did drape fibrous material, she allowed it to kink, tangle and knot itself into dangling webs and tight snarls.

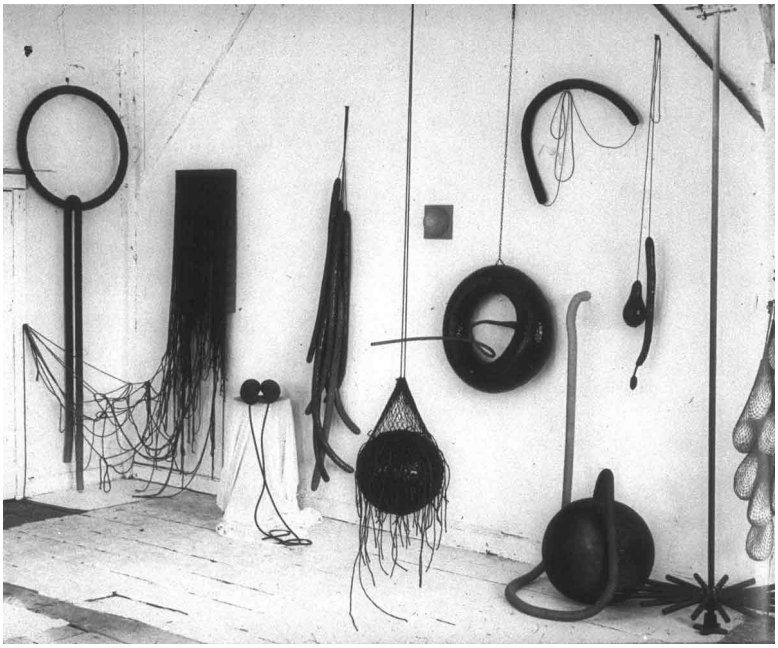


Figure 72: Eva Hesse, Collection of sculptures from 1965 – 1966, photographed in her Bowery studio, 1966.

These methods can be seen in a thematically connected group of sculptures photographed in her Bowery studio in 1966. It shows various well-known pieces in which tubular and spherical forms are built-up, wound-over, connected, dangled, extended or enclosed with rope or string mesh. As a grouping, they reveal her economy of means. Hesse used a combination of papier-mâché, plastic, string, rope and rubber tubing to create this series of forms with a repeated motif of tumescent shapes and linear connectors. Using a limited colour palette of black, white and grey, the clusters of distended tubes, open orifices, turgid balls and flaccid, dangling cording appear sombre and starkly graphic.

Over time, the linear elements in Hesse's work changed from smooth, floppy and ordered into increasingly chaotic, textured and hardened. Coating rope, string, fabric or wire in multiple layers of fluid materials such as latex or fibreglass resin, they became irregular, kinked and expressive through drying, contracting and congealing on their supports. Their irregular surfaces were further manipulated to create various looping, knotted, suspended and slumped structures. Hesse repeated the motif of the distended and extruded appendage in many of her works. They sprout from other elements, curl in on themselves, rear out in spasmodic gestures or are harnessed into large webs. In all of these works her liquid materials fuse together to create a toughened skin that becomes more fragile with age. I am particularly interested in the way in which this shifts the

role of fibre in her work from a connective thread to a dynamic, sensate and organic growth that is vulnerable to entropy and decay.

A series of artworks from 1969 through to her death in 1970 demonstrate how dramatically the quality of her linear cordage can change the reading of the piece. In images of *Right After* (1969), the suspended fiberglass cord appears to glow like a series of luminous and lacy clouds, or other organic structures such as "a shimmering web… insect-flight webwork … or glittering bramble" (Sussman & Wasserman 2006, p.45). Hesse's description of the processes used to make this work reveals that the fiberglass roving was soaked with resin before being hung to dry using metal hooks.

Figure 73: Eva Hesse, *Right After*, 1969.

Working with an assistant, this involved "climbing around, getting things up, moved about, around and hung… changing, manipulating, allowing things to

happen" (Sussman & Wasserman 2006, p.30). What resulted was a pattern of dipping curves created by the weight of the resin pulling down on the soft fibre. Appearing ordered and graceful from a distance, detail images of the installed work show how the forms disintegrate into chaos the closer you move towards the individual strands. Many irregularities become visible: some strands do not form loops but protrude at odd angles; others are jagged and frayed and some are fused together. Ultimately though, Hesse was dissatisfied with this work as she feared it had entered 'the beauty zone'.

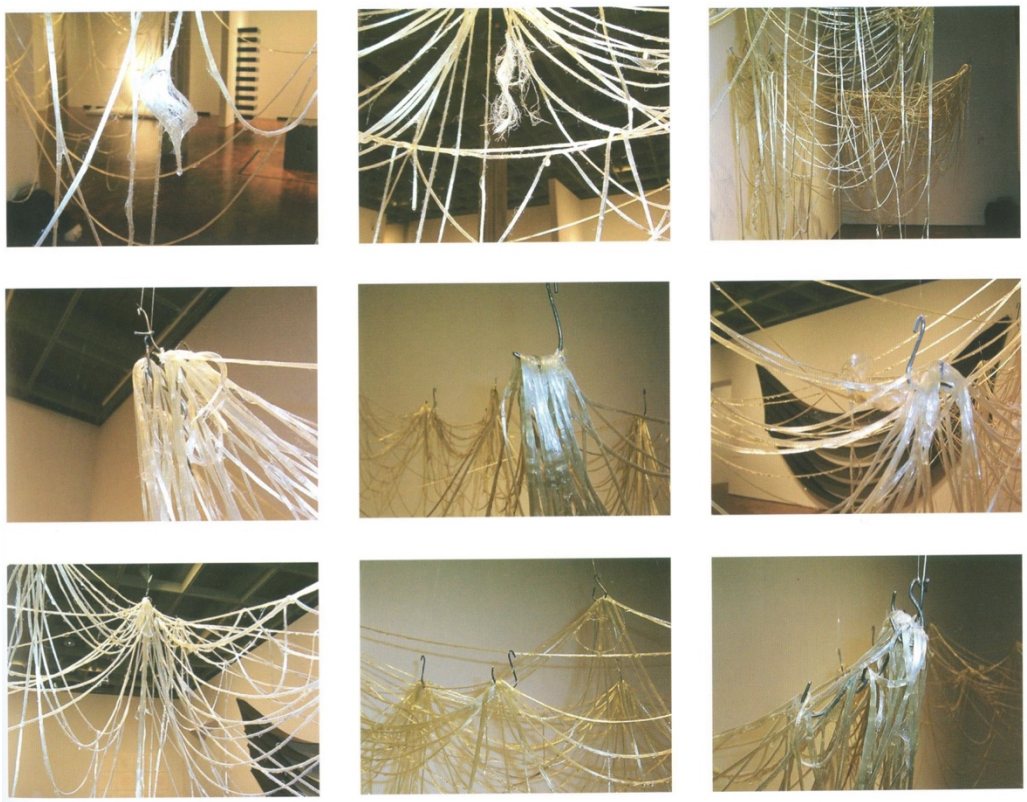


Figure 74: Eva Hesse, *Right After*, 1969. Nine views of installation details.

In stark contrast is *Untitled Rope Piece* (1970), where the rope cording is tangled, twisted and looped together in a formation that is far more organic and visceral. The layer of latex that encloses the knotted rope stiffens and immobilises the structure so that its chaotic and jangled configuration is also mummified in time. It creates the overall impression of a bizarre and dysfunctional web made up of spasmodic and jerky lines that mesh into each other or veer off into a spiky dead-end. The dynamic and disordered gestures inherent in this work appealed to Hesse and she considered it to be her most successful artwork with strung fibre.

Figure 75: Eva Hesse, *Untitled Rope Piece*, 1970.

Other studio experiments and sculptures from 1970 show how she reiterated the idea of the exposed organic extrusion. In one of these studio experiments, two lengths of coated wire are snarled around each other, coiling together and rising up into the air. The internal armature is exposed in areas where the soft coating pulls away to form nobbled ends.

Figure 76: Eva Hesse, *Untitled* - Studio experiment, 1970.

In *Untitled (7 Poles)*, this linear gesture is inflated and transformed into a series of hollow, swollen and bulging tubers. Bent over in L shaped configurations, they simultaneously reach up to create imposing vertical gestures that range from 6 to 9 feet in height, while also being anchored and slumped on the floor. They have the pale vulnerability of underground roots or vines that have been exposed to the air and are now balancing precariously on their awkward,

unstable bases. Over time, their translucent fibreglass resin skins have mottled and discoloured developing a brown and black cast and several highly coloured, bruise-like patches. At this monumental scale, they tower over the viewer and their organic qualities: irregular, rough and lumpy become even more profoundly tinged with vulnerability and pathos.

Figure 77: Eva Hesse, *Untitled (7 Poles)*, 1970.

Eva Hesse created expressive organic textures, skins and forms through the processes of wrapping, binding, looping, knotting and fusing. Built on a core of fibre, fabric or wire, these materials were transformed through the action of liquid plastic resins and latex, solidifying them into new shapes which speak of

entanglement, encasement, tension and collapse. Allowing these materials to endure and succumb to external forces, they slump and disintegrate. In doing so Hesse's work reveals the hidden and intimate aspects of existence: that which is unstable, vulnerable and decaying.

Ernesto Neto: Intimate systems of balance and tension

Ernesto Neto uses nylon and polyamide mesh fabrics to create artworks that range from small organelles and anthropomorphic forms through to room-filling pendulous pouches and immersive enclosures. Unlike the work of Eva Hesse, Neto's structures are light, colourful, mobile and charged with an intimate sensuality. Being smooth and diaphanous, they bring to mind delicate anatomical membranes, organic skins and softly spun cocoons. Without mimicking particular organic forms, he says of his approach: "I try to create a kind of fantasy of nature, and a hypothesis about a structure of a body" (Rugoff, 2010 p.23). For my project, I am most interested in the way in which the metaphorical associations and emotions that Neto achieves in his work results from the manipulation of his chosen materials into forms and structures that are co-dependent, changeable and responsive to their environment.

Over the course of his prolific career, Neto has repeated many structural motifs with only slight alterations. However, the reading of these works is often dramatically different. Made from tan nylon stocking fabric, a small work like

Sculpi (2000) demonstrates the pro-typical gesture of a creeping, legged creature that is the basis of many of his other successive works. In *Life That Spreads Out (2002)*, the number of weighted legs has grown and this form traverses the floor of the gallery and then hoists itself up to the ceiling. Trailing sandy footprints through its porous mesh, this tan skinned creature is made of the earth.

Figure 78: Ernesto Neto, *Sculpi*, 2000.

Figure 79: Ernesto Neto, *Life That Spreads Out*, 2002

In a much later work, *Animal Plant Yellow* (2013), the combination of bright yellow polyamide tulle and glass beads makes this version a far more sophisticated and exotic hybrid. Unlike the homespun earthiness of *Life That Spreads Out (2002)*, this is a synthetic life form: contained and not leaking any

substances, it is also violently coloured, perhaps signalling a warning. The logic of these forms is simple, direct and intuitively understood. The physicality of the creeping gesture, stretches the mesh taut and the weighted masses respond to gravity in the same way that our bodies are held to the ground. I am particularly interested in the way in which Neto has worked with the details of colour and material to shift the readings of these works from organic to synthetic.

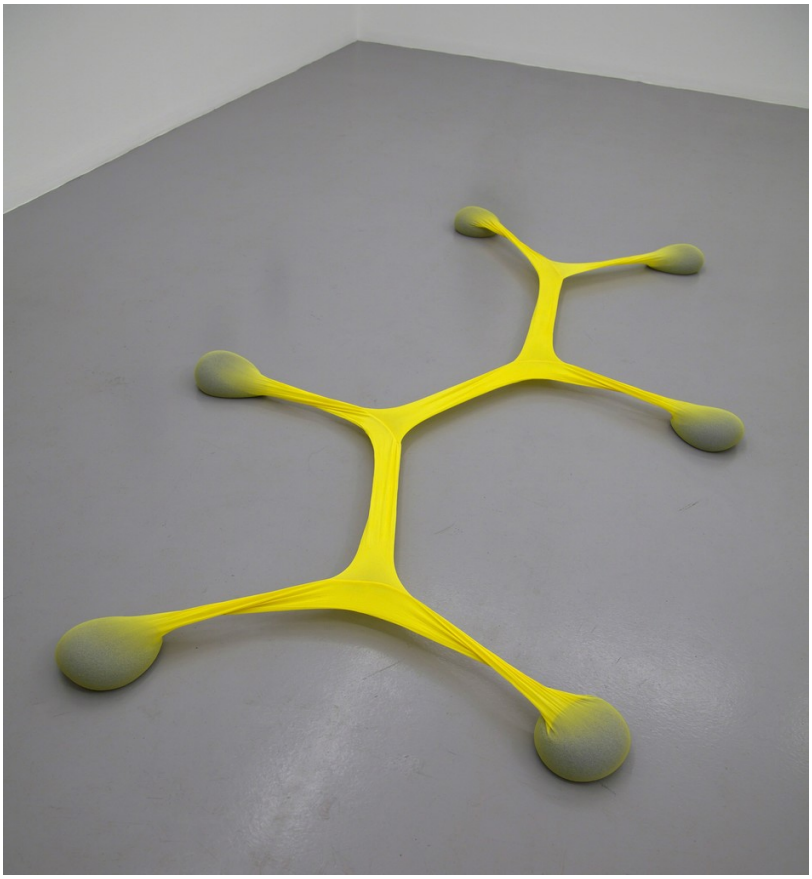


Figure 80: Ernesto Neto, *Animal Plant Yellow*, 2013

In another series of works, Neto takes the gesture of the creeping, growing form and shifts the movement from the floor to the wall. These creatures however have lost their agency and are frozen in place: they are pegged out with wooden

supports and stretched like specimens waiting for dissection. Filled with polystyrene pellets and stitched into various branching configurations, these resemble highly magnified cellular growths, slime moulds or other single celled life forms. Bulbous and squashy, their soft membranes are coloured in a cool, clinical palette of white, green and blue.

Figure 81: Ernesto Neto, *Citoaninapylea*, 2003.

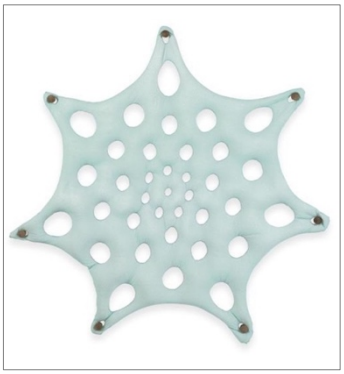


Figure 82: Ernesto Neto, *Cosmolitopylea,* 2003.

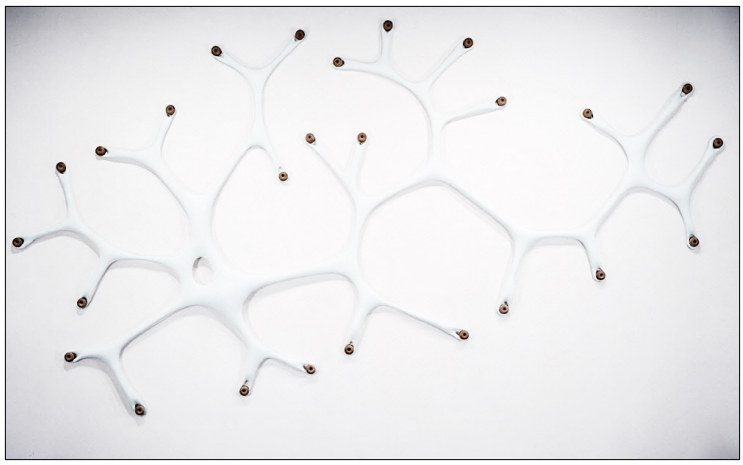


Figure 83: Ernesto Neto, *Citoanima Demoplea*, 2003.

Best known for his deeply pendulous mesh pouches, Ernesto Neto has been working with this structural form for many years. Often composed of many, repeated and interlinked components, they all share a voluptuous, swelling,

bulging quality. Of most relevance to my project, are those works that are weighted with inert materials such as lead, polystyrene and glass balls rather than those with seeds and spices that introduce an aromatic element to their installation. The fillings of these works are always revealed through the thin mesh fabric and this gives an intimacy and vulnerability to the structures; an effect that is heightened when rendered in the fleshy palette of pink and white.

Figure 84: Ernesto Neto, *Me Inside of the Drop*, 2007.

Figure 85: Ernesto Neto, *We meet here today, tomorrow elsewhere. Meanwhile god is goddess. Saint Gravity*, (detail), 2003.

In *Me Inside of the Drop* (2007), internal pouches of plastic pellets are layered snuggly on top of each other creating a soft pink mass. In a detail from *We meet here today, tomorrow elsewhere. Meanwhile god is goddess. Saint Gravity* (2003), similar materials are used, however the action of drawing up the end of the pouch creates a deep, hollow and puckered crevice at its end. These simple

gestures activate one swelling into an innocent cocoon, while the other becomes an exposed bodily orifice.

Figure 86: Ernesto Neto, *We meet here today, tomorrow elsewhere. Meanwhile god is goddess. Saint Gravity.* 2003.

In the work, *We meet here today, tomorrow elsewhere. Meanwhile god is goddess. Saint Gravity* (2003), Neto stretches pale pink and mint green polyamide tulle mesh from ceiling to floor and partially fills the tubes to create forms that dangle and penetrate each other. Green mesh is used to create large bifurcated pouches that hang heavy in the air or graze the surface of the floor, bringing to mind distended scrotal sacks or breasts. These interact with pink

mesh tubes, which penetrate the empty portions of the green mesh and emerge as swollen pink buds, filled with rice and acting as counterweights to the whole structure.

The way in which these mesh fabrics are pulled, shaped and weighted, is open to chance and allows the effects of gravity to create forms that display the opposing forces of balance and tension. There is an element of precariousness and risk in this balancing act, as one tear or rupture of the fabric would send the contents of the pouches spilling out into the surrounding space. The force of gravity and the material properties of elasticity and resistance are knowingly and deliberately played off against each other. In doing so, Neto explores the natural push, pull and strain of physical and relational boundaries, while the use of pale, pastel colours: pink; green and white, creates an innocent counterpoint to his provocative references to fertility, fusion and copulation.

For a more recent installation of *We meet here today, tomorrow elsewhere. Meanwhile god is goddess. Saint Gravity* in 2015, Neto reconfigured his work to respond to the spatial configurations of a new exhibition space. The main structural elements are still clearly there; three large green bifurcated pouches graze the floor and are penetrated by the various dangling pink nubs. However, the aerial pouches have been dropped down to floor height. This creates a significant difference in the structural organisation of the work and the readings

that it carries. From its vaulting, vertical alignment and dramatic gallery lighting in 2003, this artwork in 2015, assumes a horizontal orientation that is now flooded with diffused natural light. These factors dramatically shift the relationship that the viewer has with the work, creating either a dramatic overhead canopy that you can look up into, or in the second instance, an enclosing and intimate environment that encourages the viewer to physically negotiate around and between the forms.

Figure 87: Ernesto Neto, *We meet here today, tomorrow elsewhere. Meanwhile god is goddess. Saint Gravity.* 2003. Installation view: Ernesto Neto and the Huni Kuin, Vienna, 2015.

I am particularly interested in the ways in which Neto's flexible and self-organising forms are malleable, reconfigurable and adaptable to their space. Each of his installations reveal strategies that are used to activate his forms and

structures: iterated motifs, evocative colour palettes and the use of natural forces of elasticity, tension, and gravity. They are all linked through temporary connections that create a visual analogy to both the safety of connection and containment and the contrasting, yet related state of vulnerability, disconnection and collapse.

Lucy Irvine: Activating the complex patterning of nature

Like Eva Hesse and Ernesto Neto, Lucy Irvine also explores the language of textiles through a range of unlikely materials that have become synonymous with her practice. Applying the techniques of weaving and stitching to hardware items such as nylon cord, plastic irrigation tubing, and cable ties, she investigates their potential as a malleable linear fibre through simple motifs made by looping, knotting, and bundling. Creating a skin composed of many tightly packed stitches, these repeated gestures activate the surface tension of her structures, endowing them with the dynamic characteristics of organic forms: undulations; nodules; whorls and arcs.

I am most interested in the way in which Irvine uses connective patterns to transform her materials into sculptures that are at once familiar and mysterious. Without referencing any particular organic forms, her structures are open to interpretation and their scale and spatial configuration elicits a physical response from the viewer. Irvine creates her sculptures using an approach that is both

analytical and intuitive. Combining a nuanced and disciplined approach to rule setting, she is also responsive to surprises, allowing materials to take their own shapes: nylon cord wants to loop, while plastic tubing readily coils out into large arcs and also curls back tightly into itself. As she works on a structure, she is alert to the inherent logic of self-organising complexity which pushes and pulls the repeated motifs into shape. "Woven in tiny increments, each movement, each alignment, each cable tie stitch, slowly accumulates. A pattern emerges as a tessellation: always in motion, in response. The resulting sculpture articulates a tension between chaos and order or the known and as yet unknown" (Irvine 2013).

Figure 88: Lucy Irvine, *Before the After* (detail), 2013.

By not imposing pre-existing ideas or patterns on her sculptures, Irvine is open to the language of her malleable and linear materials in finding their own forms. As

these emerge, she enhances their effect by repeating them at smaller and larger scales within the one sculpture, exploiting the power of fractal self-similarity. Having no obvious beginning or end, they trace a continuous and dynamic relationship between material and process.

She says of her work:

> I have gravitated toward a more textile-based discourse to orient my practice. Within this context, nuances of surface, skin, process and form can be readily understood as one entity. As the woven skin of my sculpture becomes increasingly complex, the definitions of space, volume and line become unfixed. So too, do the boundaries between the intuitive and analytical in the making become increasingly blurred (Irvine 2013).

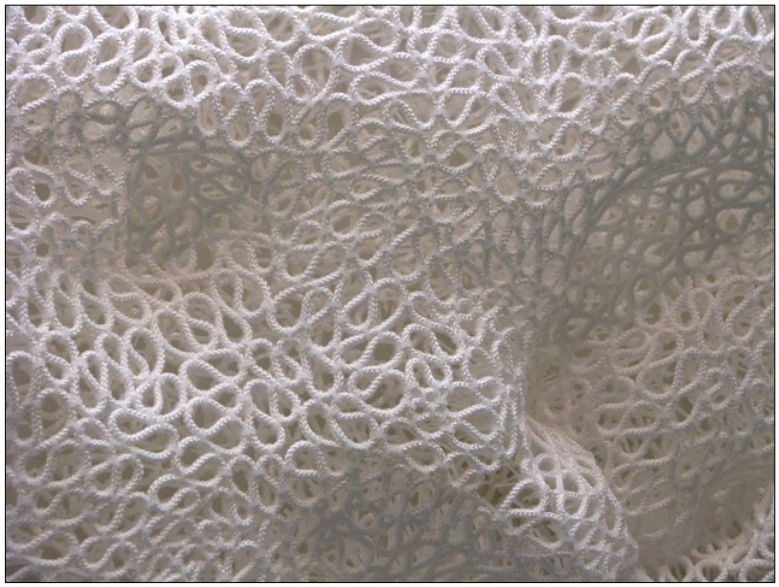


Figure 89: Lucy Irvine, *The Beginning*, 2008.

A series of works made using white nylon cord such as *The Beginning* (2008) and *Little Chaos* (2013), are shaped by hundreds of cable tie stitches that pull the cording into small petal-like loops. The loop and knot motif is repeated, growing the sculpture into undulating, hollow, self-supporting structures. Made with white electrical fencing wire, *Taking* (2014) utilises the same looped motif and cable tie stitch pattern to create a larger, more complex structure composed of crenelated nodules that poke in and out and intertwine with each other. The greater rigidity and strength of wire used in this work has allowed it to grow to larger proportions and still be self-supporting. These are all porous forms and their patterning and colour bring to mind bleached coral or calcified cellular structures. With a fluid boundary between inside and outside, they are light, delicate and penetrable.

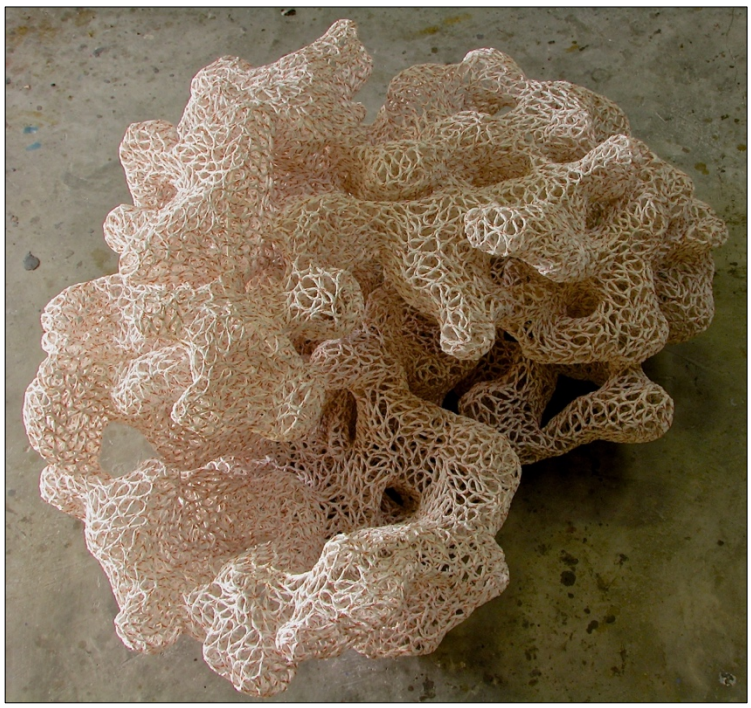


Figure 90: Lucy Irvine, *Taking*, 2014.

In contrast, are an ongoing series of sculptures made from black irrigation tubing and cable ties including *Continuous Interruptions* (2011), *Before the After* (2013) and *Made of Holes* (2016). These works are dark, shiny, densely packed, impenetrable and armoured with a striated muscular surface. Allowing the tubing to coil and loop, Irvine uses a repeated stitch motif to create wide sweeping arcs through to tightly packed whorls. The complexity of these structures is mysterious and not completely knowable: a hidden internal armature contains a secret blueprint for the tubing to attach to and allows for a dramatic increase in scale. Also concealed are the bristling lengths of hundreds of cable ties, which are tucked inside, revealing only a smooth external surface. Since 2010, Lucy Irvine has been refining and expanding upon this iterated motif. Using the same materials and processes, each successive sculpture elicits new meanings through changes in scale and spatial configuration.

Figure 91: Lucy Irvine, *Continuous Interruptions*, 2011

Continuous Interruptions (2011) is a wall-mounted sculpture designed to wrap around the corner of a freestanding wall or partition. This wrapping activates the form; it hugs its support in a tight, muscular grip and takes on the charged physical presence of an organic growth or life form. Being ominously out of place, the dark and striated glossiness of its repeated undulating forms are at once familiar and unsettling.

A very different experience is created in *Made of Holes* (2016). Situated in a darkened room, it is hard to initially perceive what is in there, as the glossy black forms merge with and are cloaked by their own shadows. As the title suggests, this structure is patterned with many large apertures and it requires active viewing to take it all in. Suspended close to the ground and occupying a horizontal space; it dips down to the floor; meets you at head height and then rears up to the roof. Individual parts of the structure read differently; some forms suggest the wide splayed shapes and elliptical holes of gigantic bones, while other parts suggest muscular intertwined roots or a monstrously large piece of kelp. Tethered and held in place by the steel cables that suspend it from the roof, this structure is pinioned and trapped. Suspended to reveal its full form and housed in the sympathetic, low light environment of museological protection, it becomes a petrified relic, its dynamic energy arrested and transfixed in the moment.

Figure 92: Lucy Irvine, *Made of Holes,* 2016.

Irvine's choice of plastic as her signature material is pragmatic, being affordable and highly suited to structural explorations of form. It also reflects her fascination with the pioneering spirit of Australian DIY culture. After migrating from Scotland, connecting with these materials was a way for her to locate herself in her new home and to make her own meanings. "I was drawn to utilitarian materials that hold our world together: piping that irrigates the soil,

cord to hold things fast, to hoist, to start motors and cable ties that fix things in a permanent but always in a seemingly haphazard way" (Irvine 2013).

Irvine doesn't speak of an ecological critique when discussing her work. However, the shiny black plastics of many of her sculptures readily evoke the black viscous oil from which they are created. The material form of these structures: hard; sealed; encasing; choking and threatening are an apt metaphor for the ecological threat of plastic pollution. Being industrial plastics, they are designed to be non-biodegradable and so her sculptures are endowed with the trait of archival longevity. Unlike Hesse and Neto, Irvine shuns instability and vulnerability by transforming the lightness and malleability of nylon cord and plastic tubing through a tight, interlocking patterning of stitches. Her forms are skinned with a carapace that is strengthened and armoured through the dynamic energy that is harnessed in their creation.

Summary

The works that I have discussed from Eva Hesse, Ernesto Neto and Lucy Irvine, have all been created through a rigorous and highly evocative exploration of their chosen materials. Using various plastics, resins and woven synthetic fibres, they have become complicit with these materials over time, learning how to coax form, structure and meaning through processes that are characterised by the repeated actions of looping, knotting, wrapping and stitching. By allowing their materials to express their innate properties, they become animated with a

dynamic presence that not only visually suggests organic forms, but also engages the viewer with a deeper, visceral sense of being in the world.

Their work also reveals strategies for exploring the theme of connectivity as a structural and emotive device. For Hesse, connections were unstable and vulnerable and this is palpably felt as her perishable materials degrade and disintegrate over time and are reconfigured in successive installations. Neto on the other hand, revels in the sensual delight of connectivity that is tactile, intuitively understood and dramatically visualised by the interplay of co-dependent forces of balance and tension. For Irvine, connections are tough, self-organising and forceful; revealing the ordered, complex and economical patterning of nature.

Reviewing such a diverse but interconnected range of works has revealed concepts and processes that have been significant for the development of my work. I will discuss my investigation of the connections between structural form, material and meaning in relation to my project methodology in the next chapter.

CHAPTER THREE: METHODOLOGY AND DEVELOPMENT OF THE PROJECT

INTRODUCTION

In this chapter I discuss the development of my project methodology and the key findings that I have made along the way. Working with a variety of stitching techniques and material processes, I have explored both ordered and chaotic models of growth. In doing so, I have considered how material properties such as: texture; density; tonality and chromatic palettes can be used to suggest the visual and structural complexity that is analogous to living systems.

A significant driver of my studio research has been the exploration of my chosen materials through tactile manipulation. Starting with woollen fibres and shifting to plastics, my processes of making have focused on the crochet loop and various knotting and binding stitches. I have explored the way in which plastic fibres, being lightweight and malleable, are able to be manipulated into a variety of discrete forms and connective modules. This also led to an investigation of the transformative potential of plastics through processes such as shredding, melting and re-forming to create new textures, densities and structural possibilities.

Throughout my project I have sought ways in which to be responsive to my materials, so that they can 'find their own forms'. I have allowed the softness or stiffness of my fibres to determine the size and shape of the stitches, loops and connectors that they make. Incrementally, these characteristics create diverse

morphologies that exhibit the internal logic of the forces that hold their shapes together: from dangling, soft and floppy through to turgid, stiff and bristling. Going beyond purely formal readings of structure and form, I have explored the metaphorical and expressive potential of materials to reveal the dynamic forces found in nature: growth; connectivity; entropy and decay.

This focus on material exploration has provided the framework for my studio methodology, and aligned it with concepts such as "thinking through making" and "the art of inquiry" (Ingold 2013, p.6). In his book, *Making: Anthropology, Archaeology, Art and Architecture*, Tim Ingold examines these methodologies and characterises the making process as a dynamic exchange between an artisan and their materials; where the form of an artefact comes into being through an interplay of forces.

Ingold states:

> In the art of inquiry, the conduct of thought goes along with, and continually answers to, the fluxes and flows of the materials with which we work. These materials think in us, as we think through them. Here, every work is an experiment: not in the natural scientific sense of testing a preconceived hypothesis, …. but in the sense of prising an opening and seeing where it leads. You try things out and see what happens.
> (2013, p.6)

During the early stages of my project, I chose to extend this methodology of inquiry beyond my studio by conducting a series of test installations. This approach allowed me to trial different elements such as sculptural configuration, lighting and spatial solutions as well as an opportunity to receive feedback from the viewing audience. I was able to 'see what happens' when my discrete elements were cast into new configurations: connecting, falling apart, self-organising and allowing for new structures to 'emerge'. This process became an integral part of my methodology and I include documentation and discussion of several test installations in this chapter.

PART ONE: GENERATING MODELS OF GROWTH

Translating algorithms into stitched models

My studio research began by investigating how to translate various mathematical models of growth into stitched forms. I considered cellular automata and binary trees and was surprised at the way in which the coded information for these systems could so easily be converted into schematics for knitting. The models that resulted from these tests assumed natural forms - a shell-like cone and a branching twig - confirming the suitability of this process for exploring structural analogues of nature.

Figure 93: Linda Erceg, Knitted model of Rule 110, Cellular Automata.

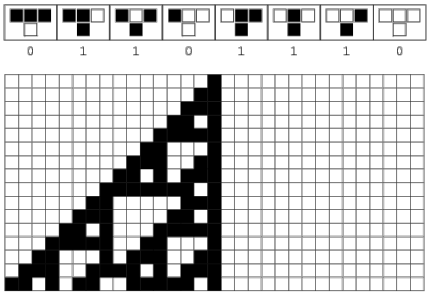


Figure 94: Schematic of Rule 110 Cellular Automata.

Figure 95: Linda Erceg, Knitted model of Substitution Tree schematic.

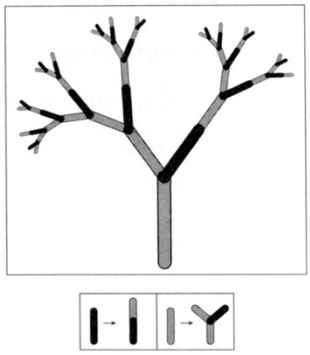
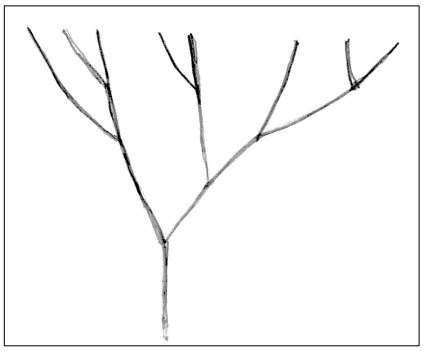


Figure 96: Substitution Tree schematic.

The Fibonacci number sequence became the focus for creating simple stitch schematics for a series of iterated branching forms. I used crochet as the stitching technique for these models as they were faster and easier to make and allowed for multiple, discrete starting points. During their creation, I noticed that the strictness of the rules used to 'grow' these forms was compromised by the

action of the yarn as it responded to the push and pull of each stitch. This was a useful discovery, as the resulting lack of perfect symmetry in these structures more accurately represents the irregularity of organic growth. I chose to amplify the textural and tactile qualities of these forms through scanning, giving heightened clarity to the woolly stitches and fluffy fibres pressed against the glass.



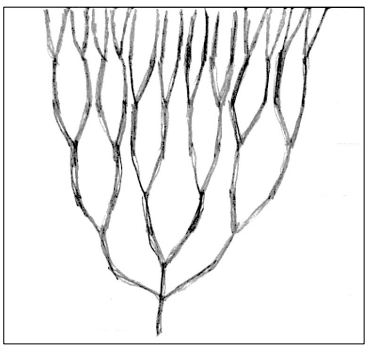


Figure 97 - 98: Linda Erceg, Fibonacci schematic (x1, left) and Fibonacci schematic (x2, right).

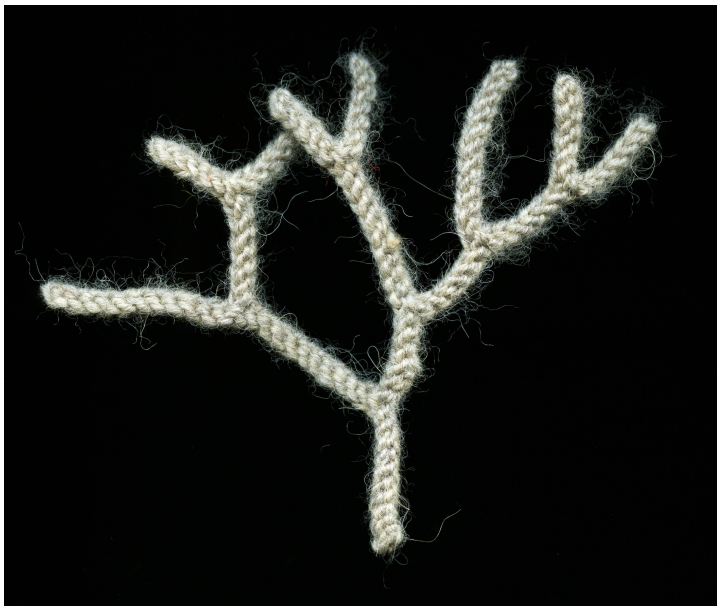


Figure 99: Linda Erceg, Crochet model of Fibonacci schematic (x1).

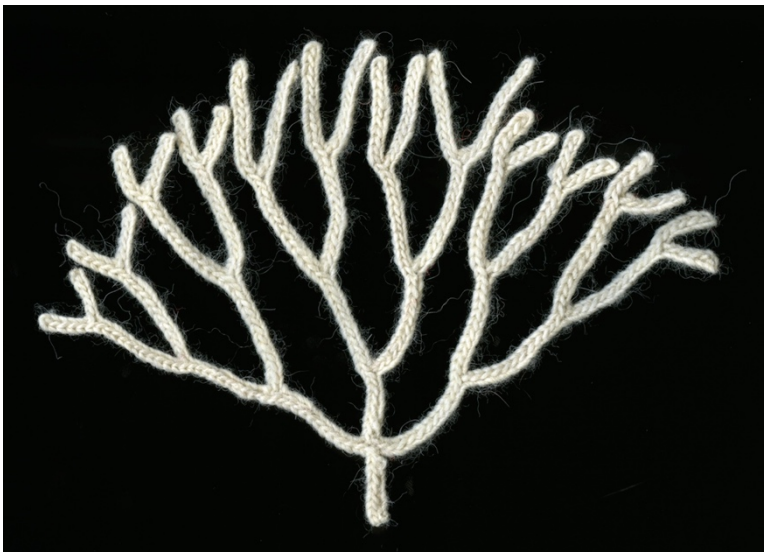


Figure 100: Linda Erceg, Crochet model Fibonacci schematic (x2)

Originally having a very defined starting point for these models, my branching trees became more rhizomatic as I expanded their growth in multiple directions. To do this, the Fibonacci number sequence was used as a starting point with subsequent branching determined by spatial configuration: a branching point was created if there was room for new growth.

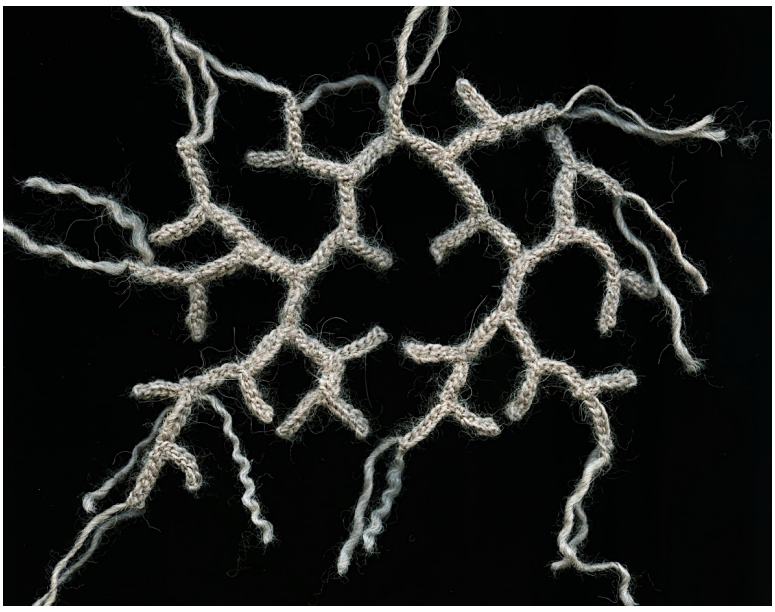


Figure 101: Linda Erceg, Crochet model of Fibonacci schematic with random branching.

Figure 102: Linda Erceg, Crochet model of Bifurcated branching (x1).

Applying these same key principles, I translated the mathematical system of binary branching into a series of three-dimensional crochet forms. Starting with a simple bifurcation, these iterated models increased in complexity through repeated divisions and variations of scale. Their pattern of growth rapidly shifted from ordered to chaotic as the branching lengths started to coil and tangle into themselves. Suggesting discrete and contained forms or vulnerable, truncated parts of a dissected organism, they show the potential that these models have for expressive interpretation.

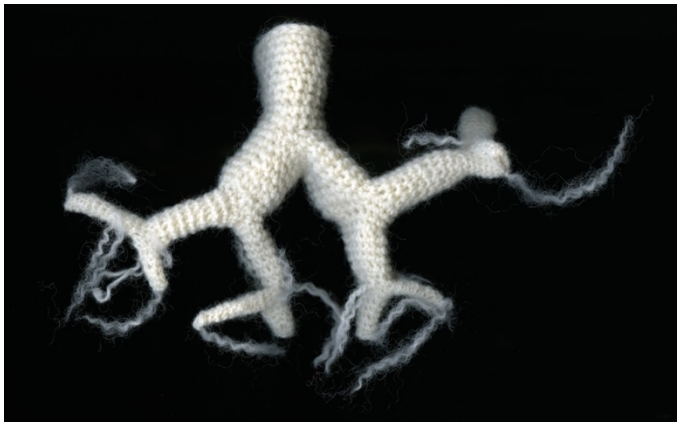


Figure 103: Linda Erceg, Crochet model of Bifurcated branching (x4).

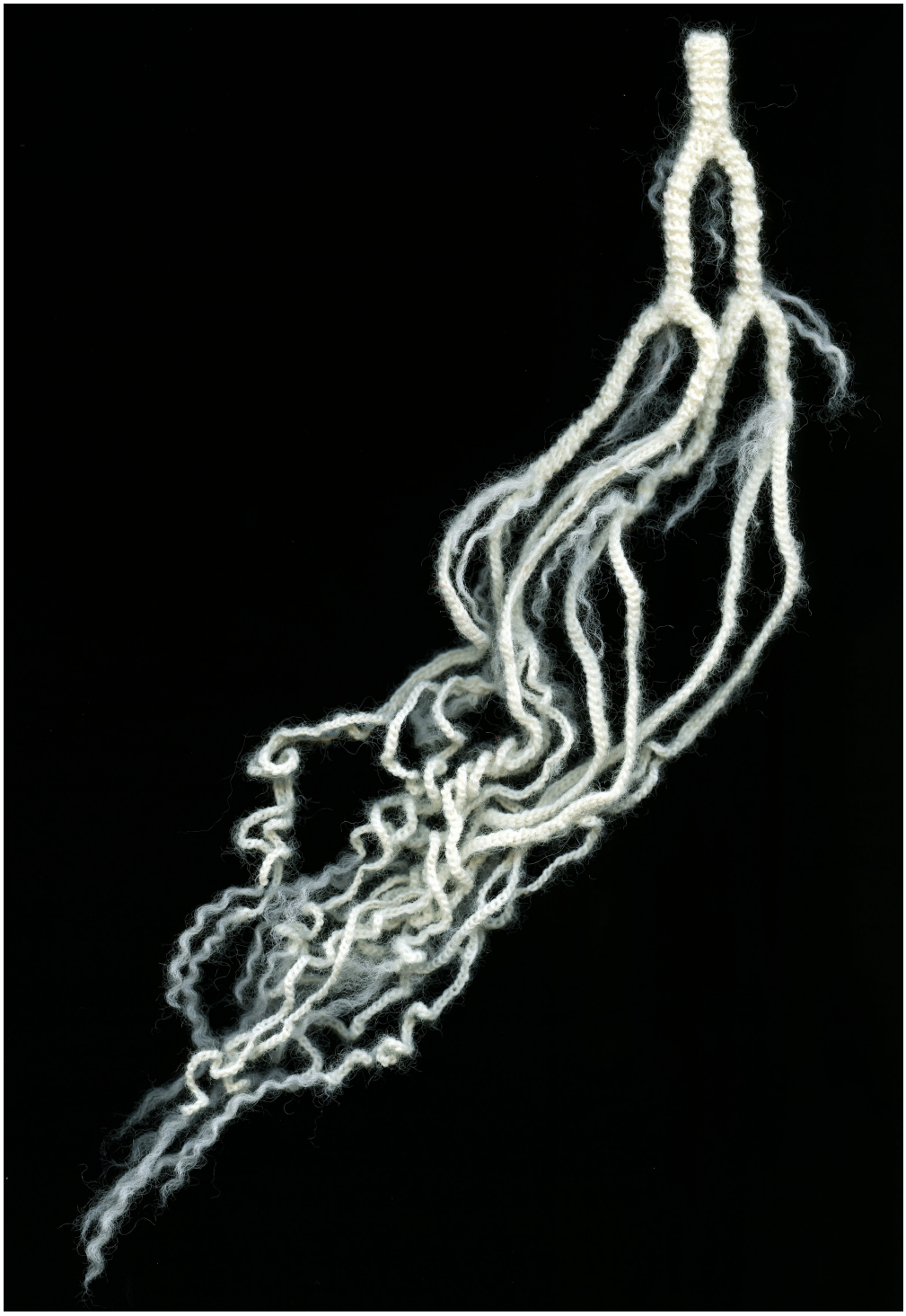


Figure 104: Linda Erceg, Crochet model of Bifurcated branching (x4).

Test Installation: Branching Systems

Having experimented with various small-scale models of growth and enlarging them through photography, my next step was to see how the forms themselves could work as sculptures and installation elements in a gallery space. I scaled up the branching models by making yarn out of t-shirt fabric. I also considered structural properties: how to make fibre firm through stuffing, inserting wires or coating with glue and how the stiffness or floppiness of a form affected its reading.

Figure 105: Linda Erceg, *Branching Systems*, 2011, test installation at Entrepot Gallery, UTAS.

After trialling various colours, I chose to limit my materials to a dark palette of black and grey fabrics in order to create a graphic contrast against the white walls. My choice of scale and colour also created a strong visual connection to fronds of seaweed and kelp. This was not an intended effect but one that I became aware of when the various forms were grouped together. I also realised that a more ambiguous reading was achieved with the sculptures made from

stuffed knitted tubes. Their soft and squashy interiors assumed rounded coils, suggestive of intestines that twisted and drooped with their material weight.

Figure 106: Linda Erceg, *Branching Systems*, 2011, Test installation at Entrepot Gallery, UTAS.

Analogies of growth and decay

After installing *Branching Systems*, I realised that the literal connection to plant forms in my work could potentially limit the overall development of my project. This led me to consider how I could create structures with more anthropomorphic and hybrid qualities that allowed for nuanced, complex and layered readings. I remembered working with the large branching fronds and how the action of crocheting a chain and then stitching back into this 'stem'

caused the entire structure to twist and undulate. This mobility was even more pronounced when the stitches were unravelled, sending the length of yarn into a frenzy of arcs and spasmodic gestures. I decided to record the actions of stitching and unravelling with a video camera and to use this footage as a starting point for further manipulation and transformation.

Recording the act of stitching made me more aware of the qualities of yarn: the way it is linear and stringy and easily manipulated by being twisted, stretched, coiled, bound, cut, pulled taught or going slack. It brought to mind the various connective tubes inside the body, including blood vessels and the many metres of coiled intestine. Choosing to enhance these corporeal analogies, I processed the raw video footage with transparent red and blue coloured filters. These sequences were then edited to give a rhythm to the movement of the fibre; a dynamic, generative pulse created through the ebb and flow of the stitches looping together and coming undone. The resulting forms were then abstracted and mirrored to become repeated motifs that morph into each other, suggesting the patterns of cell division as they grow, evolve, collapse and disappear.

While working on this series of videos, I also researched how the body represents our primary sense of an organising principle or system. I considered the fact that we are all composed of DNA and as such we are information first and material form second. The information coded in our genes tells our cells what to do through invisible processes that are out of our conscious control. In

these video works, the fluidity of information and the fluidity of the body are enacted by a malleable length of yarn which is animated by the dynamic energy of taking and releasing forms.

Test Installation: Stitch and Code

This installation consisted of four monitors that displayed one video sequence each, coupled with stitched branching forms. Soundtracks were created for each of the videos, consisting of abstract montages that incorporated watery cascades, pulsing rhythms and ticking metronomes. As this installation was in an open foyer space, I made the decision to limit the sound to headphones. In future installations of this work I plan to use speakers so that the sound elements can be featured in a more prominent way. When combined, the visual and aural rhythms build and collapse as the coiling and branching segments form a multitude of biologically suggestive and complex structures. The viewer feedback for this work was very positive. However, the stitched forms on the plinths in front of the monitors were considered to be redundant and would not be included in future iterations of this work.

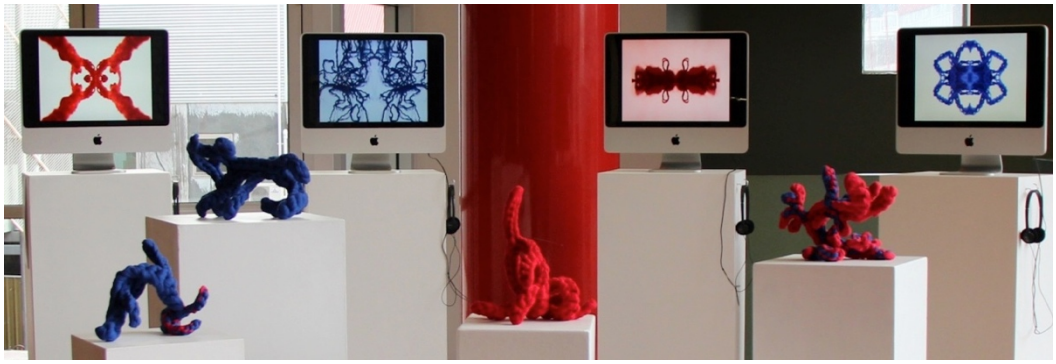


Figure 107: Linda Erceg, *Stitch and Code*, 2012, Test installation at TCotA foyer, UTAS.

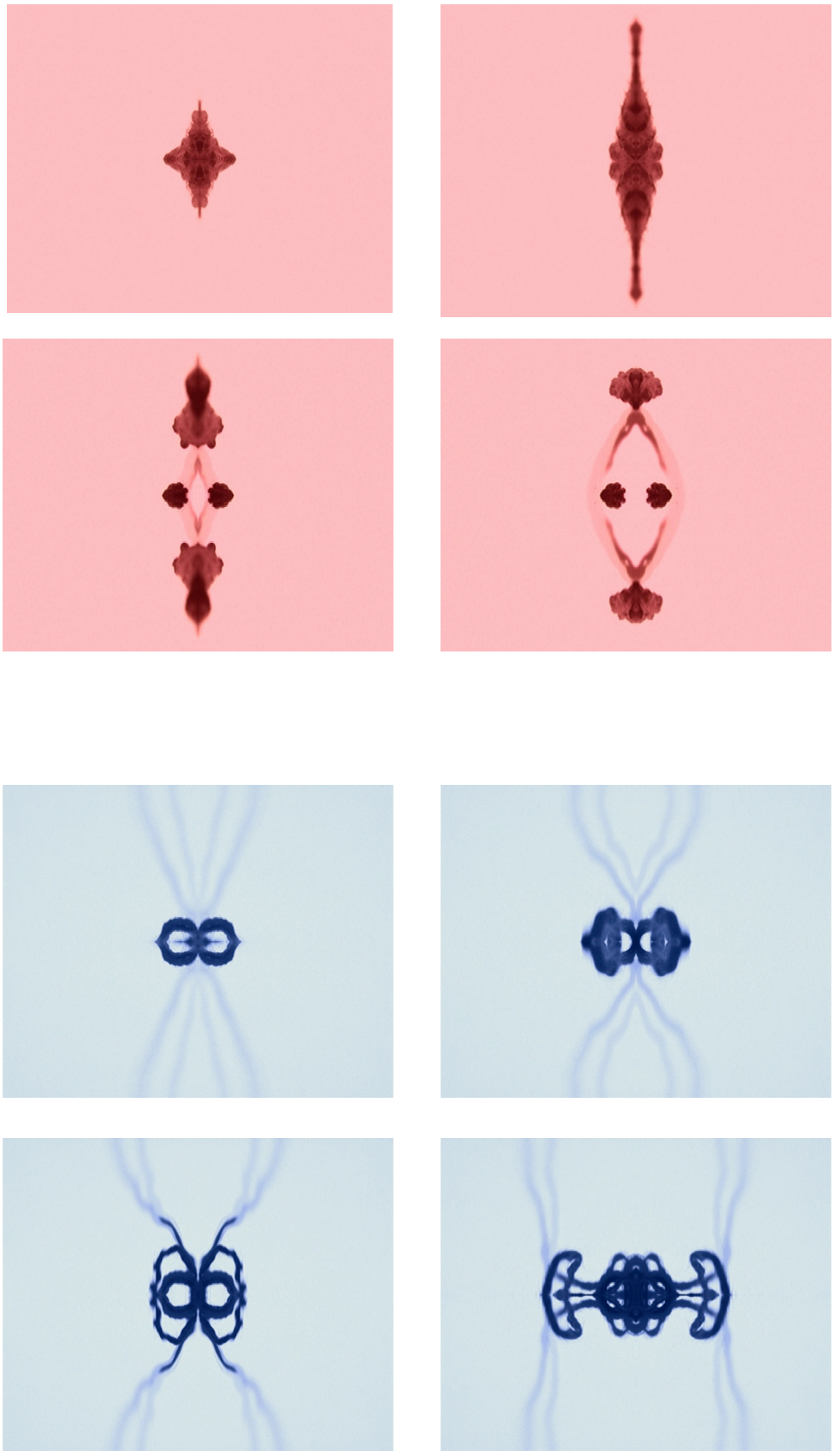


Figure 108 – 115: Linda Erceg, *Stitch and Code*, 2012, screen shots.

PART TWO: MATERIAL INVESTIGATIONS

From natural to synthetic fibres

During the course of my project I have repeatedly considered why I find manipulating and exploring materials so satisfying. Having worked with digital media and created screen based artworks for a number of years, I can admit to being drawn to the tangible world of material artefacts as a way of re-engaging with tactile experiences. This includes the action and response of directly pushing and pulling on a material to create a structural form: resulting in play, exploration and surprise.

It has been useful for me to contextualise my exploratory approach to studio methodology through a framework of material and process-oriented discovery. As my understanding of the structural potential of materials has developed, I have increasingly identified with Tim Ingold's concept of making as a "process of growth" and one that requires the artist to develop a deep 'collaboration' with their materials (2013, p.25). My studio research has taken me on a journey that is akin to Deleuze and Guattari's claim that whenever we encounter material "it is matter in movement, in flux, in variation", with the consequence that "this matter-flow can only be followed" (1987, p.409).

At the start of my studio investigation my primary material was woollen yarns. I was attracted to their tactile and textural density as well as the soft halo of fibres

that were revealed when scanned and magnified. However, these yarns also became problematic when I realised how the small stitches that I was making limited the overall size of my sculptural forms. In order to find another suitable material, I investigated making my own yarn out of t-shirt fabric and was able to make larger structures with stitches that were quicker and easier to make. Unfortunately, these forms revealed themselves to be soft, dense, floppy, heavy and lacking in structural integrity. In order to introduce some support, I tried stitching around wire but the results were clumsy and lacking the aesthetic simplicity of natural forms.

I came across some recycled plastic rope and fishing line and discovered that these materials could solve many of the structural problems I was encountering. I could create small, tight crochet stitches or large freehand loops quickly and easily and they held their shape. Wrestling with the yarn in order to unravel industrial nylon rope, or to manipulate coils of rubber tubing gave me a physical appreciation of their inherent properties and how to incorporate these into the forms. The downward pull of gravity collapsed some structures and not others, some fibres were easily coerced into regular, ordered stitches while others retained their chaotic messiness.

From this point on-wards, I increasingly focussed on plastics as the primary material for my artworks. Over time, I have come to appreciate the formal qualities of plastic in creating structural shapes - its lightness, translucence,

flexibility, colouring and ability to liquefy and reharden. Being cheap and readily available, plastic is a utilitarian and disposable material that is also loaded with social and cultural meanings. For my project, it also opens up the potential for ecological and environmental interpretations that expands the scope of my work.

Test Installation: Surface Tension/ Looping line

For this installation, I chose a number of different plastics, including fishing line, rubber tubing and coated wire and explored their various textures, colours and densities in response to the repeated action of the crochet stitch. My material palette juxtaposed neutral, almost invisible colours of grey and blue, with contrasting elements of yellow, pink and black. In this process, I discovered the way in which colour can change the reading of a form: its opaqueness; density and perceived weight can make some forms recede and others come forward; some appear to be more delicate and others robust.

The six resulting sculptures were all hung from the ceiling in a suspended cluster of tall, elongated forms. Each structure was activated by its own dynamic forces; created by the internal tensions of its stitched surface as well as the downward pull of gravity. The rubber tubing, being the heaviest material, collapsed its large looping stitches and dragged the structure into a dark line. In contrast, the stiffness of the thick yellow fishing line maintained its pod-like shape, while the lighter gauge of the blue fishing line caused its rounded contours to pucker, creating unexpected ridges and crenulations. While not referencing any

particular organisms, these hybrid forms suggest pods and husks as well as transparent, floating marine creatures. Their porous skins create a fluid tension between inside and outside, evoking a sense of absence and presence and the potential for containment and loss.

Figures 116 - 118: Linda Erceg, *Surface Tension/ Looping Line*, 2012, test installation at Carrington Smith Art Library, TCotA, UTAS.

Corporeal analogies and the language of fibre

Having found the value of plastics as a structural material for my project, the next focus for my studio investigation was to see how plastics could be used to extend the metaphorical and associative aspects of my work. Limiting myself to a red colour palette, I decided to focus on the corporeal associations of blood, viscera and interior anatomy. I sourced industrial nylon ropes in a variety of thicknesses and opacities, which unravelled to reveal a kinked and malleable fibre. Using a repeated motif of the hollow, pendulous tube, I iterated this form, allowing the properties of the fibre to create variations in texture, density and size. The red surfaces of these forms were strongly suggestive of fleshy membranes, and so I decided to amplify this association through a series of cascading net-like structures. These had the capacity to stretch out into a highly porous enveloping membrane or contract into the dense volume of a blood clot. Choosing to hang these forms, they became stretched and dangling, acting as a metaphor for the structural organisation and vulnerability of internal anatomy.

Test installation: Biomorph Red

Biomorph Red was installed as part of a group exhibition where it occupied a central open space and was lit largely with window light. Through this installation, I discovered for the first time how work made with delicate strands of fibre could lose their definition and disappear in a space. Hung from the ceiling in a series of staggered rows, the various dangling tubes, pouches and membranous nets created an overlapping sequence of interrelated forms. It was

possible to view the work from this furthest vantage point or to walk in amongst the structures and be surrounded by them.

During the course of this installation, I realised that the forms hung closest to the wall worked better than those hung in the open, central space. Most of the subtle variations of these iterated forms were lost in this installation configuration. In order to achieve the intimacy and immersion that I was aiming for, I would need to consider physical delineation with partitions and to isolate and highlight forms with lighting.

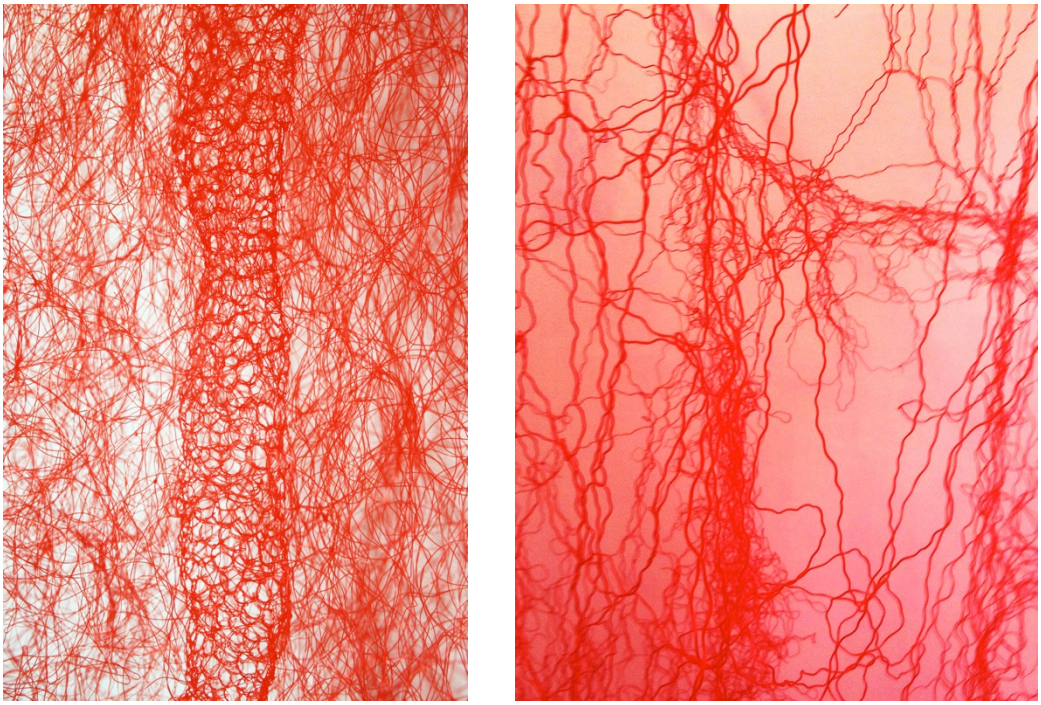


Figure 119 – 120: Linda Erceg, *Biomorph Red*, (details), 2013.

Figure 121: Linda Erceg, *Biomorph Red*, 2013, Test installation at Plimsoll Gallery, TCotA, UTAS.

Feedback on my installation of *Biomorph Red*, indicated that for many viewers, these individual and unconnected forms were not suggesting a living system. Instead they were interpreted as cast-off remnants of a life form: empty husks or dissected and petrified organic fragments. In this reading, the colour red and its association with blood and living organisms acts as a foil to the true nature of the structures as dead and lifeless remains. While this was contrary to the meanings that I had hoped to elicit from viewers, it was valuable to gain this insight as it suggests another way in which to conceptualise these forms. Planning for future installation requires a reimagining of strategies if I wish to realise an immersive experience of a living system. This feedback also provides an opportunity for me to consider how my project could go beyond the cycles of growth and generation to include the morphologies of death and mortal remains.

PART THREE: EXPLORING CONNECTIVITY

Hook and Loop: The mechanics of connectivity

Having worked exclusively with discrete hanging forms, I began to realise the importance of connectivity in evoking the structural patterns of a living system. I also looked for ways in which to incorporate my research of Bataille's concept of the 'informe' into my studio investigations. Of particular interest was the way in which this concept sees disorder as a positive state of unlimited potential as opposed to the fixed and rigid patterns imposed by systemisation and classification.

Sourcing a variety of fibrous materials such as unravelled nylon rope and monofilament fishing line, I continued my exploration of organic shapes. However, I focussed on smaller, rounded elements that resisted distortion from gravity and had no particular vertical or horizontal orientation. These factors helped to create individual units that could more easily come together in random configurations. Once again I decided to work with a monochromatic colour palette, this time choosing yellow as I noticed that many yellow plastics and fishing lines could be lit to produce a glowing fluorescent cast.

Starting with direct techniques of connection such as knotting and stringing, I also tried heat-welding strands of plastic together. While these methods did not produce very satisfying results, I discovered that heating the ends of plastic

filaments curled them into plastic nodules and hooks that readily caught on each other. These hooked plastic tendrils reminded me of climbing vines and seed burrs which use tiny hooks to 'stick' and grip in the creation of new and opportunistic connections. With further research, I discovered that the hook and loop construction of Velcro fasteners is directly modelled on the way in which seed burrs attach to the fur of animals. Inspired and modelled on a natural adaptive strategy, the nylon fibres of Velcro, like their biological analogue, provide a firm yet detachable connection that is activated by touch. In my installation work, the various plastic hooks, nodules and loops that are interwoven throughout my structures can delicately, yet securely provide new points of connection and the opportunity for random self-organisation.

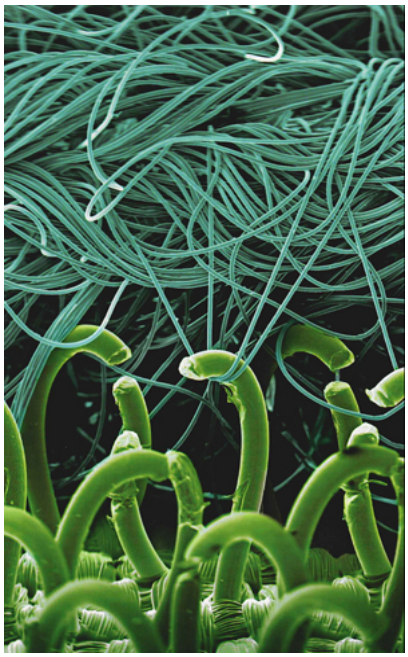


Figure 122: Microscopic view of Velcro fasteners.

Figure 123: Linda Erceg, *Biomorph Yellow* (detail of connective nodules) 2014.

Test installation: Biomorph Yellow

In my installation *Biomorph Yellow,* I chose to explore how well these connective devices could work to evoke an organic system. I used a looping crochet stitch to create rounded shapes and allowed the malleability of the fibre to determine how soft or firm the final forms would become. With the addition of heated and curled filaments, they became actively enabled and capable of hooking into each other. In the gallery space, I experimented with how to 'grow' my system of forms and chose to use a central orientation that allowed the viewer to walk around the structure. I manipulated the forms, allowing them to be stretched, compressed, distended, linked, piled or suspended in a variety of configurations. The resulting structure was animated by the competing tensions of containment and collapse as the delicate connective hooks resisted the pull of gravity.

Figure 124 – 125: Linda Erceg, *Biomorph Yellow*, (details), 2014.

Figure 126: Linda Erceg, *Biomorph Yellow*, 2014, Test installation at Entrepot Gallery, TCotA, UTAS.

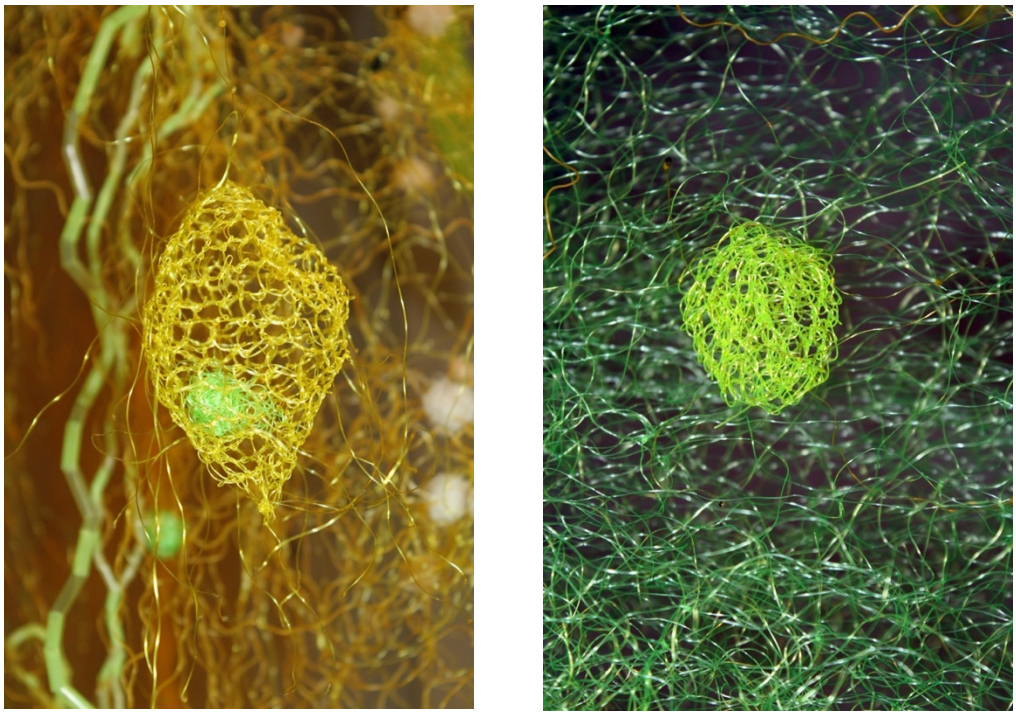


Figure 127 - 128: Linda Erceg, *Biomorph Yellow*, (details), 2014.

During this installation, I received positive feedback on the effectiveness of *Biomorph Yellow* to create an analogy for interconnected living systems. The shapes that I created were deliberately ambiguous and drew on various plant and animal forms including: seed pods; digestive tubes; worms; seeds; anatomical pouches; roots; webs; tendrils and plankton. Hung from the ceiling, these forms became suspended together in a self-organising mesh of matter. The central orientation and isolation of this work allowed viewers to engage with the intimate details: the various shapes, repeated motifs, textures, nuances of colour and precarious but surprisingly robust balancing connections. It was also possible in this installation to discern the fluorescent, luminous glow imparted by various fishing lines, creating a tension between organic and synthetic readings of this work.

I discovered that for some viewers, *Biomorph Yellow* strongly suggested a cluster of suspended marine organisms or enmeshed beach detritus. As the ocean is the primary source of simple, floating life forms, this connection is understandable. However, given that I used fishing line to make various net-like structures, it did lead me to consider if this made the work too literal and simplistic. Given that I wanted to continue using plastics as my primary material, this association alerted me to the fact that I needed to consider the significance and relevance of an oceanic metaphor as my project progressed.

Transforming recycled plastics

I next focussed my attention on exploring the structural possibilities of a variety of recycled plastics including: fruit nets; packing straps; synthetic wigs; plastic straws and scouring pads. This included experimenting with a heat gun to shrink and remould shapes as well as unravelling and shredding to create lengths of fibre. In this process, I discovered that nylon packing strap could easily be torn into linear strips. Initially intending to crochet with them, I found that these strips produced curled and pliable tendrils that retained their dense loops when unfurled and released. I decided to bring several stands of the strapping together to create coiled tufts and secured them with knotted chenille sticks. Made of fluffy, synthetic fibre, the chenille knots began to suggest growth nodes or seed heads and visually punctuated the forms. When brought together, the various

coiling tufts latched onto each other in random self-organising clumps that could be stretched out, or allowed to pack together.

Figure 129 – 132, Linda Erceg, *Seed and Spawn*, (details), 2015.

Test installation: Seed and Spawn

I tested the connective possibilities of this work titled *Seed and Spawn*, by installing it in a tall, narrow corner space where it could traverse the height of a wall. Allowing the individual tufts to stick to each other at random to form one structure, I then secured and spread this across the corner with attachment points on either side. In this configuration, it suggested a small infestation of coarse, dry plant matter that has gone to seed. Its material origins were not disguised but transformed through processes that de-contextualised these functional elements. As a structure, it actively held itself taut and stretched out across the corner space, giving dynamism and tension to the form and suggesting the potential for future growth.

Figure 133: Linda Erceg, *Seed and Spawn*, 2015, Test installation at The Ramp Gallery, TCotA, UTAS.

Exploring variability through form

In order to 'grow' this work I created more components in my studio and explored processes that transformed the surfaces of my plastics, as well as extending my colour palette with the use of dye baths and using heat to deform drinking straws into hollow husks.

Figure 134- 137, Linda Erceg, *Connect/Disperse*, (details), 2015.

The motivation for these processes was to create a more complex palette of forms, colours and textures in the overall configuration. I also reviewed the taxonomy of forms that I had now amassed and started to think of them as: husks and pods; cellular rings; fibrous nodes and seed balls; spikey vines; curled tufts and tendrils. As such, these forms started to suggest an interdependent ecosystem with an active lifecycle of growth and decay.

Test installation: Connect/Disperse

Figure 138: Linda Erceg, *Connect/Disperse*, 2015, Test installation at the Plimsoll Gallery, TCotA, UTAS.

I exhibited these works with the title *Connect/Disperse* as a reference to the many plastic nodes, hooks and loops connecting this structure and their capacity to grasp, travel and reconfigure in any given space. While installing at the

Plimsoll Gallery, I discovered that the tonal similarity of the grey carpet to many of the elements in this work had the strange effect of leaching the colour from them. Consequently, I decided to keep the whole structure up and away from the carpet and to stretch the forms through the open space, providing the viewer with several walkways. I also aimed to create a dynamic tension between loose and taut elements, contrasting the spikey lines of the branching forms with the softness of the tufted and looped clusters.

Figure 139: Linda Erceg, *Connect/ Disperse*, 2015, Test installation at the Plimsoll Gallery, TCotA, UTAS.

In bringing these individual forms together into a structure that was analogous to an ecosystem, I was interested in exploring the tensions and oppositions that are a natural part of living systems. This includes the impact of competition and cooperation as well as the lifecycle patterns of growth and decay. At this much

larger scale, there were considerable challenges in achieving the level of internal dynamism that I was aiming for. Held aloft, these intertwined forms assumed a structure that appeared vulnerable and unstable, the fragility and softness of its component parts just holding together, creating a tension that spoke more of collapse and contained disintegration rather than active generation and growth.

Figure 140: Linda Erceg, *Connect/ Disperse*, 2015, Test installation at the Plimsoll Gallery, TCotA, UTAS.

On reflection, in future installations of *Connect/Disperse* I will seek to further activate this work by reviewing the range of materials and structures that I bring together. I realised that more hybrid and ambiguous forms were needed,

especially as a foil to those structures which read very literally as vines and leafy clumps. As all of the gestures in this work are similarly light and delicate, the introduction of larger, denser, heavier textures and forms could be used to create a visual counterbalance for these many small, detailed components. These elements could also provide greater structural integrity, allowing for more vigorous and dynamic connective possibilities.

While not being completely satisfied with the resolution of *Connect/Disperse* in this installation, I was also reminded of the fact that these individual forms are endlessly reconfigurable. As in natural systems, any individual element can be separated to create a new growth in a new environment. This concept of regeneration is central to my project, which associates the physical action of looping a length of fibre; connecting the end with the beginning, with the continuity of a lifecycle and the evolutionary imperatives to repeat and iterate.

PART FOUR: GROWING COMPLEX SYSTEMS

The shared dynamics of organic and abstract forms of growth

Throughout this project I have repeatedly considered how closely I want my forms and structures to read as natural, organic elements and consequently, how to avoid overtly literal interpretations. In the feedback to my test installations, I have also been alerted to how difficult it is to control the metaphorical

interpretations that viewers bring to the work. This has increasingly prompted me to consider how to use ambiguity and abstraction so that there is enough space for interpretation of the work.

A study of any natural or mathematically modelled system reveals that they are complex sites, constantly managing and adapting to change. In my studio investigations, I have increasingly aimed to explore both morphologies of form and the innate tensions and dynamics which activate all systems. Central to this premise is the idea that systems are not passive, but are actively ruled by the laws of cause and effect. If a system becomes too successful and outgrows its capacity for expansion, it collapses. On the other hand, if it is deprived of essential needs, it becomes stunted, withers and dies. As my studio work has progressed, it has become increasingly important for me to investigate how to visualise this contested and delicate balance that is inherent in all systems.

Test installation: Growth System 1

Exploring how to visualise the characteristic internal dynamics of systems became the next focus of my studio investigation. I started by considering how I could use my materials and processes to translate the basic geometries of line and sphere into a series of ambiguous and abstract forms. I found that the simple action of a repeated crochet stitch creates a length of looped line that coils together to form a volumetric mass, taking on a packing arrangement

similar to foam bubbles. It can also be stretched out and pulled taut into a linear chain that provides multiple attachment points for other elements. Using various thicknesses of fishing line and nylon rope, I compared the ability of these amorphous volumes to contract into themselves or expand out into connective webs.

Figure 141: Linda Erceg, *Growth System 1*, 2016, Test Installation at the Carrington Smith Library, TCotA, UTAS.

I also explored the potential for creating stronger, self-supporting linear elements by threading cut pieces of plastic tubing onto lengths of wire, interspersing various textures and creating a malleable yet firm line that can be randomly kinked and shaped. I cut and disassembled black plastic mesh into

branching forms that resisted vegetative associations through its colouring and distinctive regular grid. The final structural element that I created was achieved through heat-treating various coloured plastics, liquefying and contracting them into dense spherical balls.

Figure 142 – 143: Linda Erceg, *Growth System 1*, Test installation at Carrington Smith Library, TCotA, UTAS.

These structures were brought together into a test installation titled: *Growth System 1*. Starting with the volumes and lengths of looped line, these were used to transverse the corner space and create anchor points and a webbed scaffold for the other elements to connect to. I pushed and poked the black rods into this webbing to provide both additional support for the structure and visually

punctuate the delicate coloured line. The black mesh fronds were cast up into sections that arched up and back into the corner space, their curling, gridded forms clinging to the looped line and providing a contrast to the heavier black rods. The numerous coloured balls were also cast into the structure and allowed to hook and attach in random patterns.

A self-contained corner installation space allowed me to experiment with lighting and to see the effect that shadows can make on my work. I found that these shadows created an immersive three-dimensional space by activating the walls and floor with shapes that both duplicated and transformed the sculptural forms. The ambiguity and abstraction I had achieved in the overall structure was contrasted with the organic patterning of the elongated and overlapping cast shadows. The lighting also accentuated the subtleties of texture and colour, further complicating readings of synthetic and natural. The volumetric masses and congealed balls of highly coloured yellow, pink and lime green plastics glowed with an artificial and toxic luminescence, contrasting with the subdued coppery sheen and opaque ochres of other forms. The positive feedback that I received for this installation confirmed that through the actions of hooking, linking and balancing, I had been successful in suggesting the internal dynamics of a growing, interconnected system.

Figure 144- 145: Linda Erceg, *Growth System 1*, 2016, Test installation at Carrington Smith Library, TCotA, UTAS.

The toxic fecundity of plastics

During my project, I have repeatedly considered what it means to be using plastics as my primary sculptural material, both from a personal and cultural perspective. Floating, ocean borne plastics and ghost nets provide a real world ecological context for my project. Representing a system that is growing and self-generating, the problem of plastic waste becomes a timely analogy for the way in which benign patterns of growth can become malevolent and dangerous. Representing growth that is unwanted and out of place, it chokes out the natural ecosystem, replacing the natural and organic with a synthetic imitation. It is possible to imagine plastic as a shape shifting, fluid and invasive chameleon that dominates its environment with its toxic fecundity.

In my project, I am looking for ways in which to allow plastic to declare its true nature as malleable shape shifter and ecological coloniser. The quality of 'plasticity' in a biological context is the ability of an organism or ecosystem to be adaptive and resilient in the face of change. By using plastic to mimic the patterns and forms of organic growth, it takes on the role and agenda of an opportunistic introduced species: proliferating with its invasive and noxious growth. Increasingly I have become interested in ways in which the individual structures that I make can connect to each other in an ecosystem where connectivity is seen to be opportunistic, competitive and aggressive. My work often resolves itself as suspended, interconnected weblike structures. Like their

natural counterpart, webs can be benignly invisible or camouflaged in their environment, however their function is often dangerous and predatory.

My sculptures mimic the forms, structures and colours of living organisms while also revealing this ability as a dangerous and malevolent fraud. The conflict between organic and synthetic is provoked and actuated by the fact that I am using the material that threatens biological survival in order to envision organic structures. I aim to temper the seductive appeal of plastic and its innocently colourful, smooth and translucent surfaces with its material duplicity and potential for dangerous misuse.

Test installation: Growth System 2

The starting point for this next work was the aim of creating a growth system that both visualised the mutable, unfixed structure of the rhizome and the insidious capacity of plastics to act as an invasive and toxic threat. This led me to consider types of natural growth that are characterised as opportunistic, unwanted, 'out of place', malevolent, threatening or destructive. These references brought to mind examples that ranged from the mildly innocuous through to dangerous and lethal - tumble weeds, jungle vines, mould blooms, bacterial infections and cancerous tumours.

When planning my installation strategies, the various architectural elements of the gallery space became integral to creating the experience that I wanted the viewer to have. I used a large wooden beam as an attachment point for an encircling growth that bristled out toward an adjacent panel from which sprouted another spiked form. These black, thorny structures situated at head height, impeded easy access and created a barrier for the viewer to negotiate. Made from deconstructed plastic meshes they were soft and pliable, which belied the impression of aggressive and dangerous barbs.

Figure 146: Linda Erceg, *Growth System 2*, 2016, Test installation at Ramp Gallery, TCotA, UTAS.

I used the wall surfaces as attachment points for my various elements to attach, creep, wrap, sag and connect to. The front panel created an opportunity for elements to wrap around and 'grow' into a narrow interior corridor. This small,

confined space provided an intimate encounter with the work as viewers avoided brushing up against the plastic filaments and their exposed connective spikes and hooks.

Figure 147 – 149: Linda Erceg, *Growth System 2*, 2016, Test installation at Ramp Gallery, TCotA, UTAS.

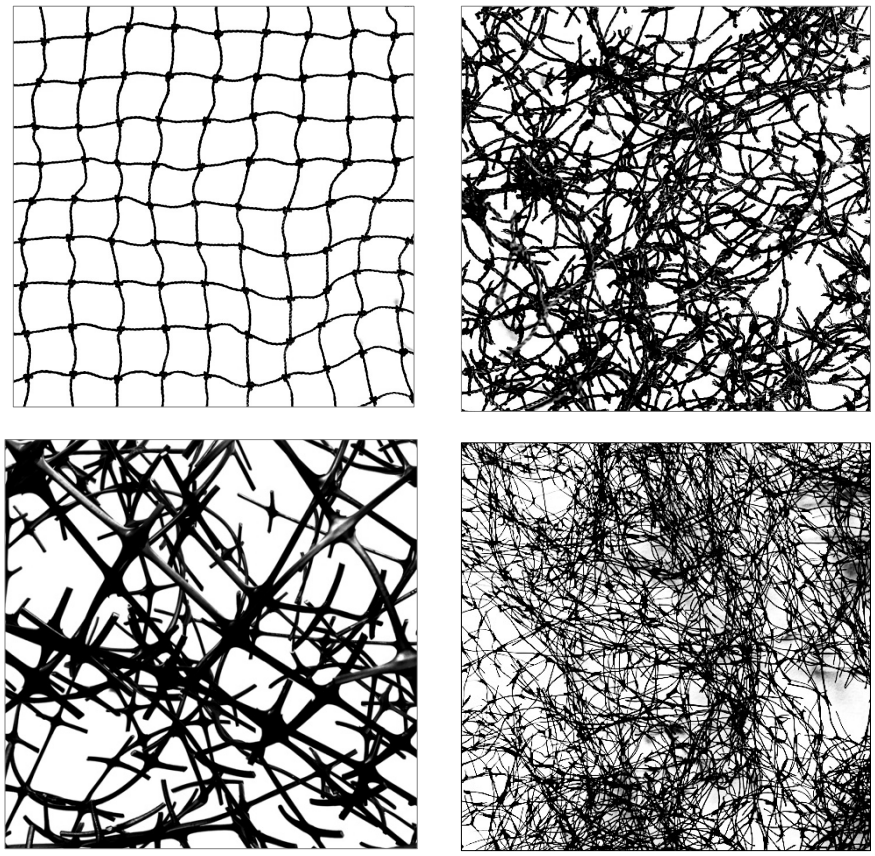


Figure 150– 153: Linda Erceg, Studio investigations, 2016.

The taxonomy of forms that I explored in this installation were an extension of those developed for *Growth System 1*. Using a similar colour palette of black and bright, fluorescent colours, I sourced a range of plastics including garden trellis, bird mesh, ropes, fishing lines and nets. Experimenting with nets and meshes, I found that by cutting, shredding and tearing they could be transformed into branching structures where the exposed knots and plastic welds formed new connective nodes. These easily tangled into each other to create clumps and balls with varying degrees of 'stickiness' that could adhere to each other in the formation of much larger structures.

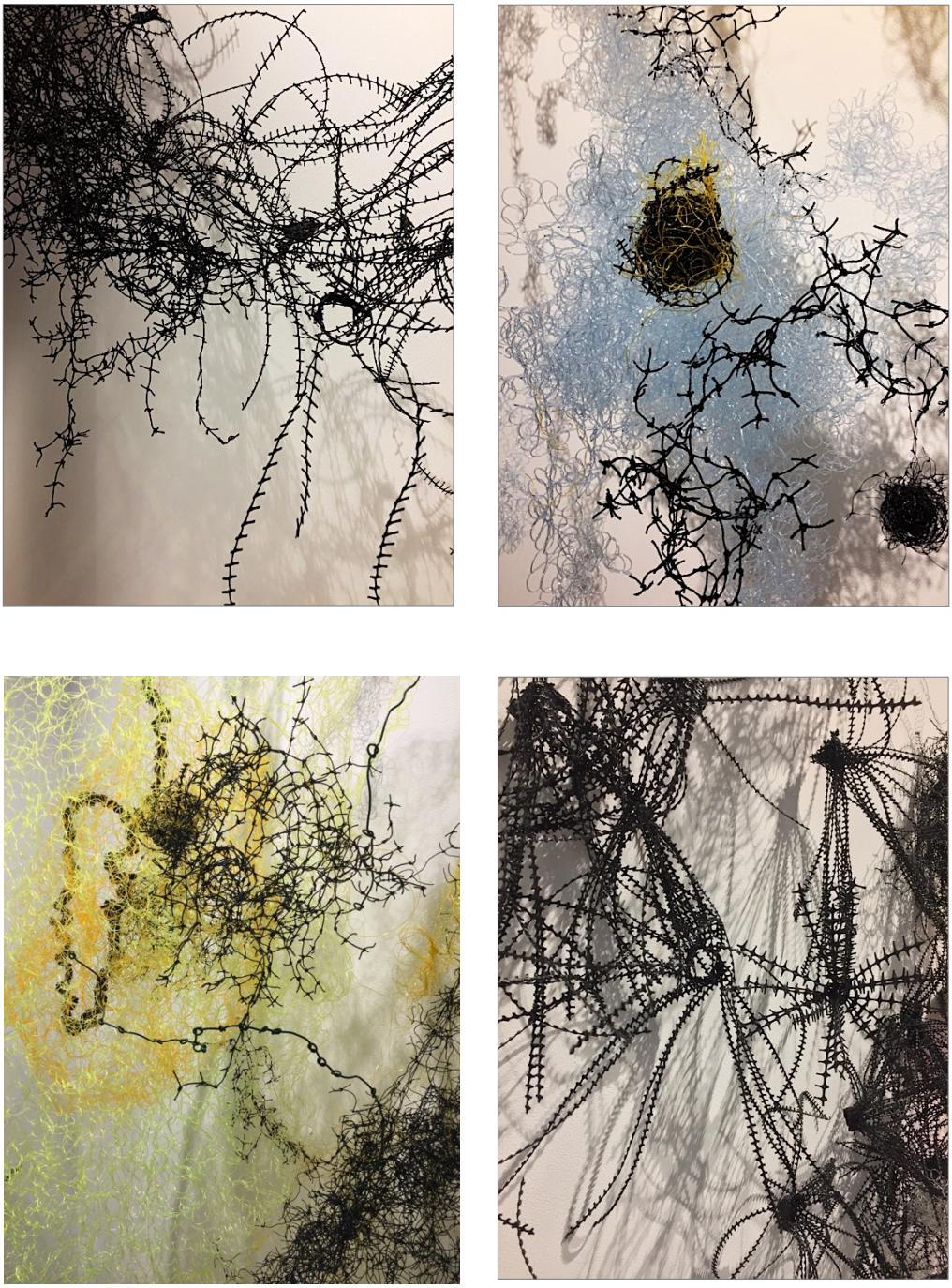


Figure 154 – 157: Linda Erceg, Studio investigations, 2016.

I also incorporated various types of plastic coated wire, with their dynamic, coiled energy introducing a new structural element and a scaffold for support and attachment. These wires were also knotted, wrapped and stitched with black

plastic fibres that were melted and fused together to create dark, textured skins. As self-supporting structures, these elements were explored for their ability to trace out graphic linear gestures: actively fingering out into space, sprouting and claiming new territory or succumbing to the sag of gravity.

Figure 158: Linda Erceg, *Growth System 2*, 2016, Test installation at Ramp Gallery, TCotA, UTAS.

New morphologies were also tested. Most significantly, I experimented with a large, flat, circular pink disk of regular looped stiches. Suggesting a permeable, cellular layer, what is behind this surface can be perceived as bounded, contained and protected. The anatomical pinkness of this form prompts

associations of skin, membrane and tissue, which is reinforced by its glossy, stretchy malleability and ability to be peeled off and reattached.

Figure 159: Linda Erceg, *Growth System 2*, 2016, Test installation at Ramp Gallery, TCotA, UTAS.

Viewer feedback for this test installation confirmed that I had successfully evoked the physicality of a sprawling growth pattern that invades, spreads, adapts and insinuates itself into the architecture of a space. The forms and structures were perceived as alluding to natural forms without being overtly literal and so allowed for varied interpretations. Many viewers responded to the use of molten black plastics in this installation as a sinister element with strong associations to decay and the black, slimy texture of rotting matter. Likewise, the clumps and clusters of black branching filaments that attached, spread and hung

down from other forms were interpreted as aggressive and opportunistic parasitic growths.

The overarching perception of this installation was of a space overrun by an unstable and threatening system of growth and rotting decay. Viewers who responded strongly to this work spoke of the psychological tension evoked by the conflicted appeal of attractive and repellent elements. They referred to the contrast achieved between the highly coloured, luminous and neatly contained forms with those that were dark, amorphous, rough and messy. Relationships between the forms were a point of discussion with the perception that various elements were connected through the dynamics of competition and cooperation. For these viewers, there was also a sense that the work was activated by the intuitively understood logic of a 'living' system, suggesting the potential for further transformative change.

Summary

Exploring and manipulating plastic fibres through a range of iterative and systematic processes has provided me with an understanding of the structural capacity and associative meanings of these materials. Through my studio experiments and test installations, I have developed a morphology of forms and connective structures that have the capacity to be infinitely reconfigured and adapted to new spaces. The shifting structure of my work makes it difficult to grasp as one finite form, and it evokes a tangible sense of the dynamic forces of

an active, living system. The structural ensembles that I create can be folded in on themselves to create new connections or parts can be torn off and used to spawn new forms. This becomes a way of visualising the metaphor of non-hierarchical connectivity that is constantly evolving to create new forms and connective spatial relationships. In doing so, my work becomes a rhizomatic map of growth that is constantly shifting, travelling, coming together and falling apart.

The true character of plastics as a shape-shifting, invasive, 'undead' material is physically enacted through my installation practice where connectivity is revealed to have emotive and metaphorical meanings. Expanding out into singular threads and contracting into dense interwoven meshes and congealed balls, my work is most successful when the tension between order and disorder is held in a tight balance. In those cases, it elicits an awareness in the viewer of the transience of connection and the vulnerability of collapse and decay that is part of the natural cycle of all living things.

Conclusion

In this research project, I have investigated how plastic fibres can be manipulated to create artworks that visualise the growth, adaptability and collapse of living systems. My primary concern has been to find ways to explore the inherent tensions between order and disorder through the creation of structural and connective forms that allow for patterning, self-organisation and entropy to take effect.

As a starting point, I drew on a number of scientific theories and mathematical algorithms used to model growth and transposed them into stitched forms. Initially working with a direct correlation between number patterns and stitches, I modified my approach to allow for digression, deviation and error in order to simulate the natural processes of mutation and natural selection. Exploring evolutionary variability through my studio methodology proved to be an effective strategy in creating forms that displayed both the ordered patterning and irregular messiness of organic life.

As my studio investigation progressed, I directed my attention to exploring the material and structural properties of plastic fibres including their colour, texture, density, translucence, lightness and malleability. Over time, I have developed a rigorous and experimental approach to manipulating and transforming these materials. Stitching, wrapping, looping, knotting, shredding, cutting and heating were all processes that I used to explore and extend their potential. Most

significantly, I investigated the ability of plastics to deform and melt when heated, developing connective burrs and hooks that provide attachment points and assist in the growth of larger and more complex structures. This also led to a wider investigation of heated plastics, resulting in masses of greater density and texture and triggering new analogies with natural forms.

Through my studio research, I have become complicit with my materials, seeking out and responding to the innate forces and dynamic potential of various plastic fibres. I have found that allowing my materials to take their own shapes gives forms that have a structural authenticity, a believability that makes them appear to be natural and organic. On the other hand, forcing a material into prescribed shapes without any deviation or flexibility gives 'lifeless' results that appear contrived and out of place with my evolving taxonomy of forms. My forms and structures have come to trigger many metaphorical associations: cocoons; webs; nets; seeds; cells; cancerous tumours; plant growth; floating marine life and the anatomical interiority of tubes and pouches.

I gained valuable insights for how to develop and progress my project through investigating the work of artists who combine iterative processes with a deep connection with and rigorous exploration of their signature materials. Ruth Asawa, Margaret and Christine Wertheim and Tara Donovan all apply predetermined rules in their practice, however their work demonstrates the

value of allowing chance, variability and mistakes to create an evolutionary process of natural selection that determines the final outcome of their forms.

Likewise, the work of Eva Hesse, Ernesto Neto and Lucy Irvine shows how the patterning that results from iterative processes have the potential to elicit a wide range of metaphorical triggers. Their materials are woven, stretched and wrapped into structures that reveal the physical and emotive nature of corporeal vulnerability, sensuous tactility and the precarious and unstable forces of interdependent connectivity. Of particular interest to my project has been the way in which all of these artists create sculptures and installations that are activated by a 'liveliness' that suggests the internal dynamics of an evolving system. They seem capable of expanding and proliferating or conversely, to be on the brink of collapse and disintegration.

A central theoretical argument for my project has been the concept of the rhizome, which provides a model for understanding the nature and meaning of connectedness. Materialised through plastic fibres, the diverse taxonomy of forms produced through my studio methodology has enacted this theory through a connective strategy of entanglement and 'stickiness'. While the initial results of combining structures that are unstable, malleable, transient and reconfigurable is one of chaotic disorder, the use of repeated iterations and manipulation have revealed self-organising, evolving and emergent patterns.

The concept of rhizomatic openness also validates the ephemeral nature of the art works that comprise my test installations and final exhibition submission. There is no singular, cohesive, final 'whole' to be achieved. Instead, there is a never-ending series of reconfigurations that are each unique and created in a process that relies on random attachments as well as highly orchestrated selections and edits. My works are most successful when they appear to have an internal logic that is activated by the complex patterning of shape, texture, colour, connectivity and the inter-relationships between forms. It is this quality of infinite malleability and reconfiguration which also distinguishes my work from many of my contextualising artists. Using an ever-increasing system of hooks, nodes and loops, my work has shifted from the creation of individual forms to evoke more strongly the sense of a living system which is constantly evolving.

Throughout the course of this project I have looked for ways in which to inflect my forms and structures with empathic triggers. I have considered growth and connectivity as a way of thinking and feeling that can be embodied through abstract forms. What does it mean to be held together with delicate and fragile bonds that barely touch? How is this different to the grip of a sticky and suffocating entanglement? I experience a degree of empathy with my forms as they assume the patterns of growth; clumping together, branching out into space, swarming across surfaces, defying gravity with unexpected sprouts or collapsing under their own weight.

This empathy is also enacted through my body when I install my work. During this process, I physically manipulate my forms and structures – stretching elements across space, rubbing and felting fibres into balls and measuring the space that I work with in steps and arm spans. I throw elements at each other and see what sticks - pushing and pressing elements together, continually casting-out and gathering in. There is a connection to my personal capacity to lift, carry, push, pull and manipulate. The installation process is both the sum of my gestures and the chance connections and configurations that the various elements adopt through self-organisation. I use the logic of both order and chaos to shape my structural vocabulary as it evolves through a process of natural selection that prompts me to favour some forms and abandon others.

Throughout my project, the inherent tension of using plastics to visualise the structure and interconnectedness of biological systems has been a key factor in the development and realisation of artworks. While I have utilised plastic fibre in ways which imitate the processes and growth of living systems, at the same time, my work alludes to the ways in which plastics behave like an 'undead', toxic invader that proliferates and chokes out all other organisms. The tensions between the organic and the synthetic, between growth as regenerative and destructive are visually and physically enacted through my artwork. My plastic fibres create connective structures which are infinitely malleable, adaptable and reconfigurable, mimicking the behaviour of living systems and simultaneously materialising a dangerous threat.

The materiality of plastic fibres as they expand out into individual threads, compress into dense meshes of looped stitches or congeal into molten balls, have infused a complex set of associative elements into each growth pattern. Drawing on a range of concepts such as: complexity theory; rhizomorphic connectedness; corporeal embodiment; the 'informe' and entropy, these ideas have been intermeshed with the real-world context of ecological damage and climate change.

Living in a world of changing climate and ecologies, includes living with the cycles of disintegration and reconfiguration. My artworks contribute to the contemporary, interdisciplinary field that imagines life in the Anthropocene. It does so by providing a way of visualising, thinking and feeling through the states of fragmentation, transience and adaptability as future realities in a damaged world. Acknowledging that growth can be both a positive and negative force, the generative systems created in this project seek out their own logic through strategies that entangle, bind, hold, protect and support. My artworks reveal the true nature of plastics as an infinitely malleable shape shifter and invasive, ecological coloniser. The title of this project - Biomorphic Loop – confirms the unending cyclical nature of this investigation and the potential for future work that extends, proliferates and transforms into unexpected offshoots and new growths.

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APPENDIX 3 - CURRICULUM VITAE

EDUCATION

2011 - 2017 **PhD** (Fine Art)**,** Tasmanian College of the Arts (TCotA), University of Tasmania. (Current study)

1999 - 2001 **Masters of Fine Art** (Media Arts) RMIT, Victoria.

1995 - 1997 **Bachelor of Art, with Honours** (Photography), Tasmanian College of the Arts, University of Tasmania.

1985 - 1988 **Bachelor of Education with Honours** (Science) Edith Cowan University, Western Australia.

SELECTED SOLO EXHIBITIONS

2016 *Growth System 2*, mixed media installation, **Ramp Gallery**, TCotA, UTAS.

2016 *Growth System 1*, mixed media installation, **Carrington Smith Art Library**, TCotA, Hobart, UTAS.

2014 *Seed and Spawn*, mixed media installation, **Ramp Gallery**, TCotA, UTAS.

2014 *Biomorph/Yellow*, mixed media installation, **Entrepot Gallery**, TCotA, Hobart, UTAS.

2012 *Surface Tension/Looping Line*, mixed media installation, **Carrington Smith Art Library**, TCotA, Hobart, UTAS.

2012 *Branching Systems*, mixed media installation, **Entrepot Gallery,** TCotA, Hobart, UTAS.

2008 *Shadowlands,* digital prints - **Red Gallery**, Melbourne.

2005 *Vox Virtua*, Interactive multi-media installation, **Project Space Gallery**, Melbourne. Funded by **Australia Council** (New Work) and **Arts Victoria**, (Presentation and Promotion).

2004 *Vox Virtua (Virtual Kiss),* Multi-media installation, **Gertrude Contemporary Art Spaces**, Studio 12 Exhibition, Melbourne.

2004 *Urban Legends*, Multi-media Installation, **Clubs Gallery**, Melbourne.

2002 *Skin Club***,** Interactive animation and sound installation, **Next Wave Festival**, Digital Arts Programme. At the **Centre for Contemporary Photography.** Funded by **Film Victoria** (Interactive Screen Arts) and **Arts Victoria** (Arts and Professional Development).

2001 *Friendly*, video and sound installation in collaboration with Melanie Velarde, **West Space Gallery**, Melbourne.

2000 *Skin Pack,* video and sound installation, **Mass Gallery**, Melbourne.

2000 *Soft Styler,* video and sound installation, **Centre for Contemporary Photography**, Melbourne.

1999 *Paradise Inferno,* colour photography, **Stripp Gallery**, Melbourne.

SELECTED GROUP EXHIBITIONS

2015 *Island Bride* (Dr. Dorita Hannah) with *Biomorphs* (Linda Erceg) in OPB 2015 (2nd *Oceanic Performance Biennial*), *Sea-Change: Performing a Fluid Continent***, PSi, Performance Studies International**, Rarotonga: Cook Islands**:** 8 -11 July, 2015.

2015 – 2016 *Island Bride* (Dr. Dorita Hannah) with *Biomorphs* (Linda Erceg) in *Fluid States: Performances of UnKnowing*, a globally dispersed, year long conference (held in 14 countries), **PSi, Performance Studies International.** Prague: 20 June 2015; Tokyo: 29 August 2015; Guam: 2 June 2016.

2015 *Biomorph/ Disperse and Connect* in New Makings: an exhibition in motion, mixed-media installation - **Plimsoll Gallery**, Hobart, UTAS.

2013 *Biomorph/ Red* in Investigations: A survey of research higher degree projects in the Tasmanian College of the Arts, mixed media installation **- Plimsoll Gallery**, Hobart, UTAS.

2013 *Corporeal Loop* in Domain: a contested landscape, mixed media installation - Ten Days on the Island, festival event at **Domain House, UTAS**, Hobart.

2011 *Stitch and Code* in Convergence Lab (Research Environment), textiles, video and sound installation – UTAS, **Tasmanian School of Art,** (TCotA) Hobart, UTAS.

2008 *Untitled Series* in The Mars Project, digital prints - **RMIT Project Space Gallery,** Melbourne.

2007 *Playworld* in RMIT Print Residency, digital prints - **RMIT Project Space Gallery**, Melbourne.

2007 *Punch Line* in Game Art, video and sound installation, Exhibition curated by Mejan Labs in collaboration with the Royal Academy of Fine arts and the Royal University College of Fine Art Stockholm. **Mejan Labs, Stockholm.**

2005 *Punch Line* in the National Erotic Art Award, video and sound installation, National group exhibition curated by Artrage and sponsored by Adultshop, examining the use of the erotic and pornographic in contemporary art. **The Bakehouse Gallery, Artrage Festival**, Perth.

2003 *Punch Line* in Staring in the Dark, video and sound installation, Group exhibition exploring the appropriation of pornography by popular culture. **Australian Centre for Photography (ACP)**, Sydney and **Gertrude Contemporary Art Spaces**, Melbourne: Studio Exhibition.

2002 *Skin Club* at Crossing, New Australian Art, Exchange with **RMIT Project Space Gallery University of Industrial Art and Design (UIAH), Helsinki, Finland**, *Skin Club* travel funded by **Australia Council**, New Media, Presentation & Promotion funding.

2002 *Skin Pack* and *Emulator* at - Lookalike, **Nederlands Foto Institute,** Rotterdam, Holland.

2001 *Skin Pack* and *Emulator* at Virtual Girlitude, **Off-Corso,** Rotterdam, Holland and Our Perfect Dream, **Gallery 5020**, Salzburg, Austria.

2000 *Soft Styler* at Blink Video Lounge, - **Australian Centre for Contemporary Art**, Melbourne.

2000 *Emulator* at Our Perfect Dream, Australian / Austrian Exchange – **First Floor Gallery**, Melbourne.

SELECTED GRANTS AND AWARDS

2015 **Graduate Research Office (GRO)**, Conference and Research Travel Scheme, UTAS.

2006 **National Erotic Art Award**, sponsored by Artrage and Adultshop **(WA).**

2004 **Australia Council**, New Media, New Work Grant.

2003 **200 Gertrude Street**, Studio Artist, Melbourne, (Two-year residency).

2003 **Australia Council**, New Media, Presentation & Promotion funding.

2002 (ISA) Interactive Screen Arts **(Film Victoria)** and Arts Development **(Arts Victoria).**

2001 Pat Corrigan Artist's Grant **(NAVA).**

1999 Australia Postgraduate Award **(RMIT).**

Appendix 4 – OTHER WORK

Collaborative Project – (2015 -2016)

***Island Bride* (Dr Dorita Hannah) with *Biomorphs* (Linda Erceg)**

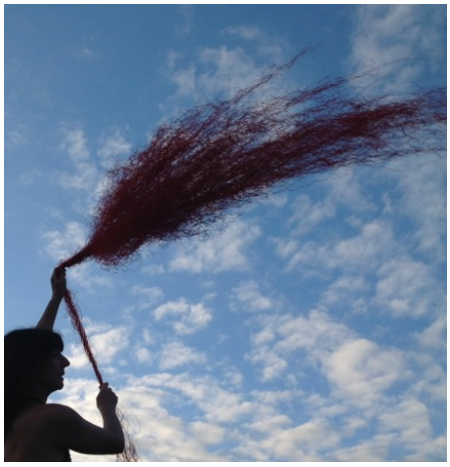


Figure 1-3: (top left, top right and middle) Testing *White Biomorphs,* photos Dorita Hannah, 2015. Figure 4: (bottom left) Testing *Red Biomorphs*, photo Carol Brown, 2015. Figure 5: (bottom right) *Island Bride* (Dorita Hannah) with *Biomorphs* (Linda Erceg) in performance at the *Sea Change: Performing a Fluid Continent*, symposium Cook Islands, photo Linda Erceg, 2015.

In addition to researching and resolving my PhD project, I have also completed a number of other significant projects during my candidature. In February 2015, Dr Dorita Hannah (Research Professor of Interdisciplinary Architecture, Art and Design, UTAS), invited me to collaborate with her on a series of artworks. We worked together to develop my sculptural *Biomorphs* into performative body objects that could be worn and activated by dancers. In doing so, the *Biomorphs* became an integral part of Dr Hannah's project: *Island Bride*. By bringing these works together, we sought to create a figure that could embody the oceanic ecology of the Anthropocene. The resulting water-bound bride casts out nets and is herself entangled in a mesh of ghost nets, plastic detritus and organic forms.

In order to develop this work, I used the large, hyperbolic nets from *Biomorph Red* as a starting point for an exploratory series of crenellated, exponentially grown structures. Working with white nylon rope, I stitched coralline, ruffled forms that could be worn as layers of bridal mesh. These forms could also be detached and used as nets to trap, comb and cast about in water and on land. After a successful application for post-graduate research funding, I travelled with Dr Hannah to the Cook Islands for the *Oceanic Performance Biennale* (OPB 15). We developed *Island Bride* with *Biomorph*s in situ, and presented the work as part of the *Sea Change: Performing a Fluid Continent* symposium. While in the Cook Islands, I also exhibited a series of *Biomorphs* and other forms that I made using locally sourced plastic detritus. The techniques that I used to 'grow' these structures incorporated traditional stitching and stringing techniques used to create floral leis.

The *Island Bride* and *Biomorphs* have also travelled to Prague, Tokyo and Guam and in each location, a site-specific series of actions have been developed by Dr Hannah and her performers. During this time, I have created a series of red, white and black *Biomorphs* as both sculptural installations and performance

elements. The use of recycled plastics and marine detritus has become part of my ongoing strategy for sourcing materials and a way of contextualizing my project within the contemporary ecological concerns of the Anthropocene.

Figure 6 – 8: Linda Erceg, *Biomorph / Island Forms*, mixed media installation, exhibited as part of the *Sea Change: Performing a Fluid Continent*, symposium, Cook Islands, July 8 – 11 2015.

Figure 9 – 11: *Island Bride* (Dorita Hannah) with *Biomorphs* (Linda Erceg) in performance, (top) Prague 2015, photo Dorita Hannah, (middle) Cook Islands 2015, photo Rob Linkhorn and (bottom) Guam 2016, photo Dorita Hannah.

Appendix 5 – OTHER WORK

Artist in Residence Project

Artist in Residence: Linda Erceg

Project: School Reef – St. Michael's Collegiate, Hobart

Dates: August – November, 2015

Class: Design in Textiles, Year 9

Teacher: Julie Brock

Figure 1 – 4: Details of 'reef building' with Year 9 *Design in Textiles* students, St Michael's Collegiate, Hobart, 2015. Photos by Linda Erceg.

In 2015, I was invited by Julie Brock, Art and Textiles teacher at St Michael's Collegiate, to work as an artist in residence with her students. Given that I would have the opportunity to work with her classes over a three-month period, I suggested that we create a textile-based art work for the school. After viewing the 'school reefs' created as part of Margaret and Christine Wertheim's *Hyperbolic Crochet Coral Reef Project*, we decided to explore this idea with her year nine *Design in Textiles* class.

After speaking with the students, it was decided that we should make this an intergenerational project by inviting parents, siblings and grandparents to join us in the creation of the reef. Each week, contributors to the reef brought their latest tests and creations to 'show and tell' to the rest of the group, sharing skills, techniques and new insights. Very quickly we amassed a large number of organic forms that interpreted the hyperbolic formula in new and unique ways. Various supports and materials became incorporated into the pattern for basic ruffled structures to produce a diverse taxonomy of forms.

The *St. Michael's Collegiate School Reef* was opened on December 1, 2015 by the School Principal, Mrs Judith Tudball. It has also been officially registered as a 'satelite school reef' and documented in the Institute for Figuring, Crochet Coral Reef website at: <http://crochetcoralreef.org/satellite/stmichaels.php>.

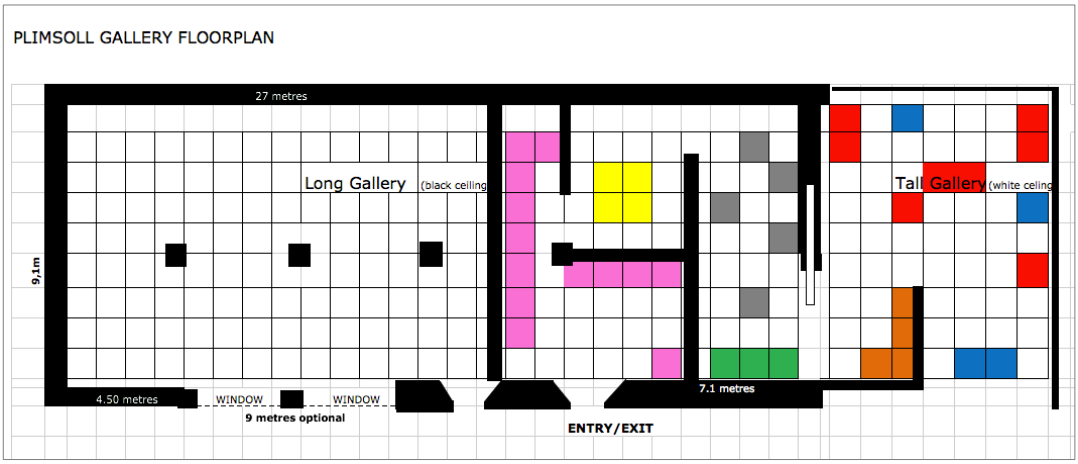
LIST OF CONTRIBUTORS

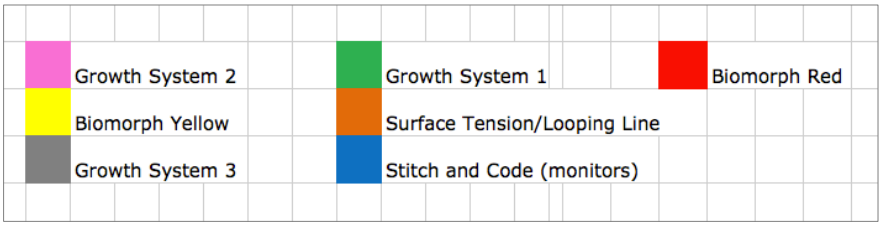
Linda Erceg (Artist-in-Residence), Julie Brock (Teacher), Sancia Bingham, Mrs Barbara Blackman, Miriam Boult, Grace Elrick, Rebecca Fleming, Samantha Fleming, Tania Fleming, Kyra Gallagher, Mrs Helen Hall, Mrs Joan Harrison, Scarlet Iwanovski, Olivia Kingston, Kate McMahon, Mrs Sarah McMahon, Brittney Siedentopf, Mrs Pat Voss, Abi Zeckendorf.

Figure 2: *St Michael's Collegiate School Reef*, Hobart, 2015. Photos by Julie Brock.

Appendix 6: Documentation of examination submission

Venue: Plimsoll Gallery, Hobart, Tasmanian College of the Arts, March 2017





Examination Submission

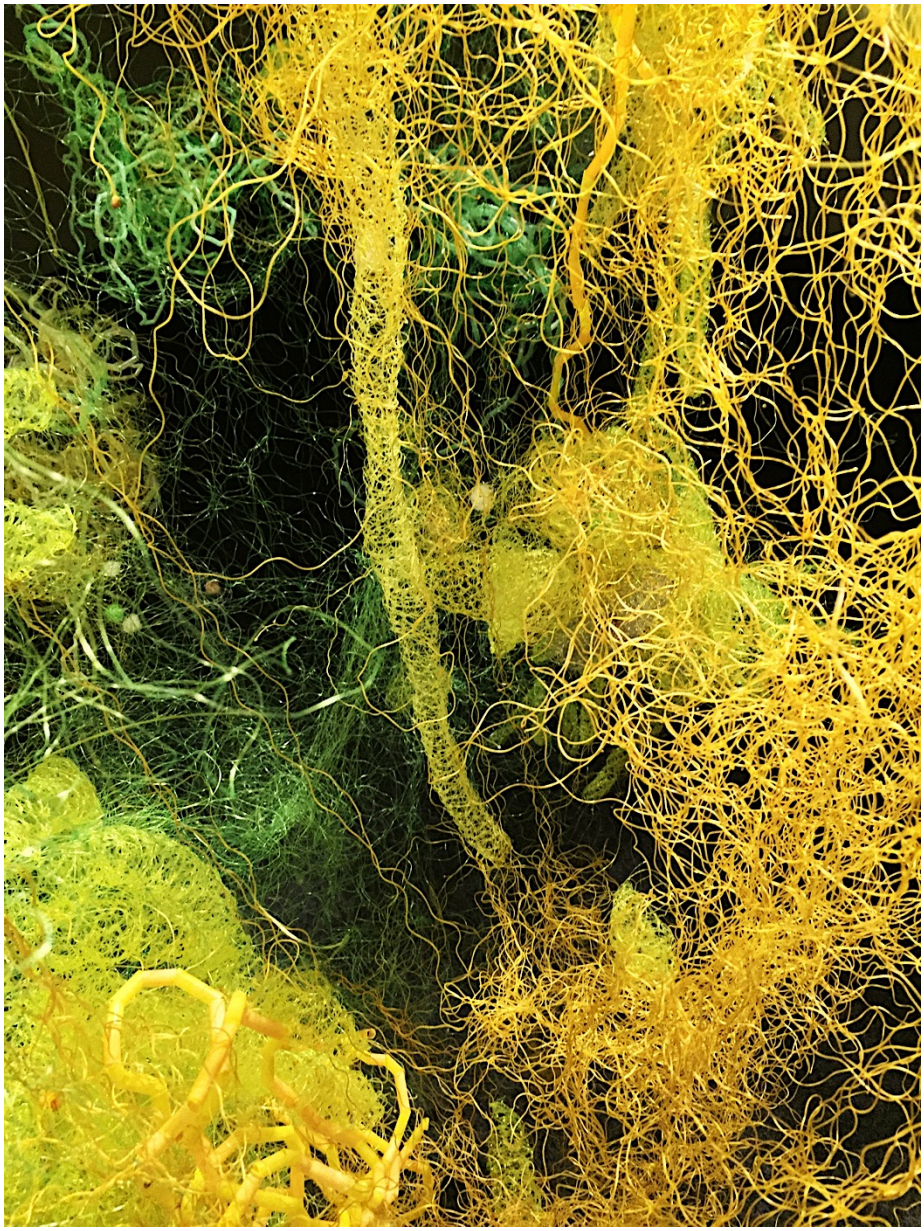
My exhibition plan was designed to create a maze-like and immersive pathway to lead viewers through the artworks in the reverse chronological order of their creation. Starting with my most recent work, *Growth System 2*, a series of discrete rooms and narrow corridors provided the installation sites for works that hung, stretched, draped, coiled and intertwined into each other. The flat pink disk that characterises *Growth System 2* was pulled taut to trap and contain a diverse morphology of soft, enmeshed elements as well as a black, whip-like form that snakes inside its confines.

Linda Erceg, *Growth System 2*, 2016, examination submission, 2017, photographs: Michelle Powell.

The viewer next passed through a narrow corridor where black, sinuous elements creep and trail over-head and across the walls. This darkened space is latticed with shadows that multiply the interlocked forms.

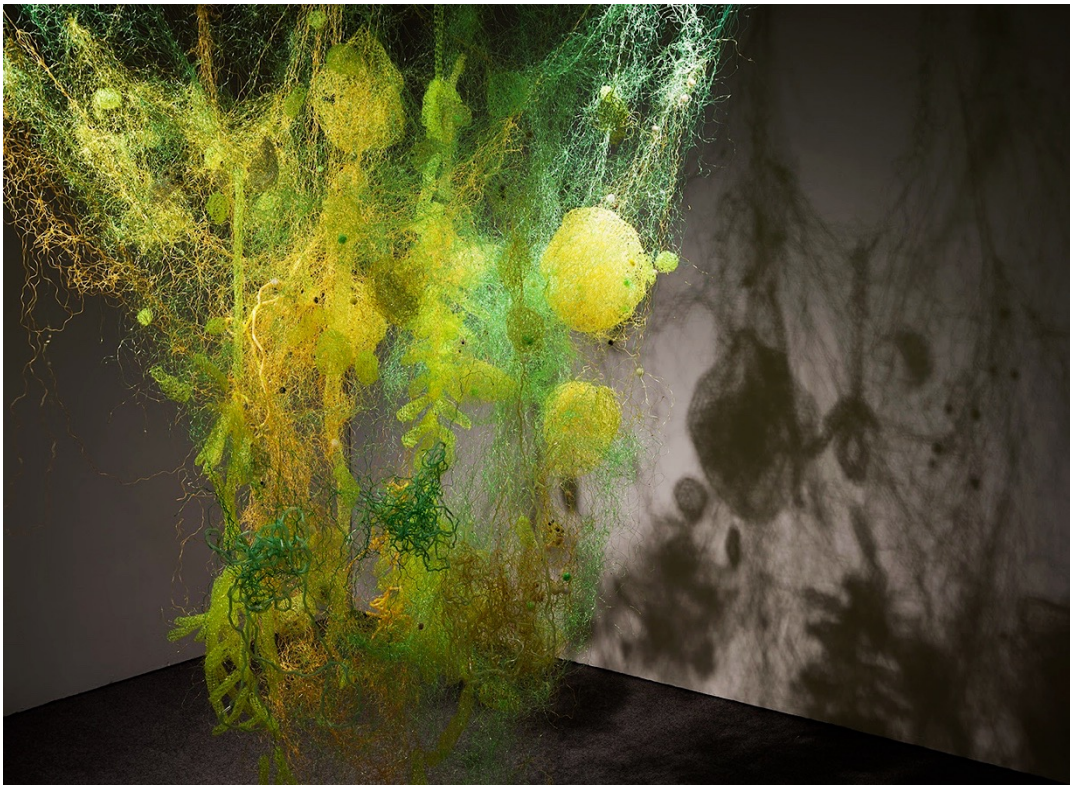
Linda Erceg, *Growth System 2*, 2016, examination submission, 2017, photographs: Michelle Powell.

Linda Erceg, *Growth System 2*, 2016, examination submission, 2017, photographs: Michelle Powell.



Linda Erceg, *Biomorph Yellow,* 2014, examination submission, 2017, photograph: Linda Erceg.

Throughout this installation I used low-light bulbs and spot-lighting to highlight individual forms and throw distinct shadows onto the walls. This was particularly effective for *Biomorph Yellow*, which was hung in a central orientation in a small, square-shaped room. I pulled all of the structures and meshes into one spiralling conical form to create a central mass. Individual filaments were then pulled out and stretched taut to connect the structure to the dark recesses of the ceiling.



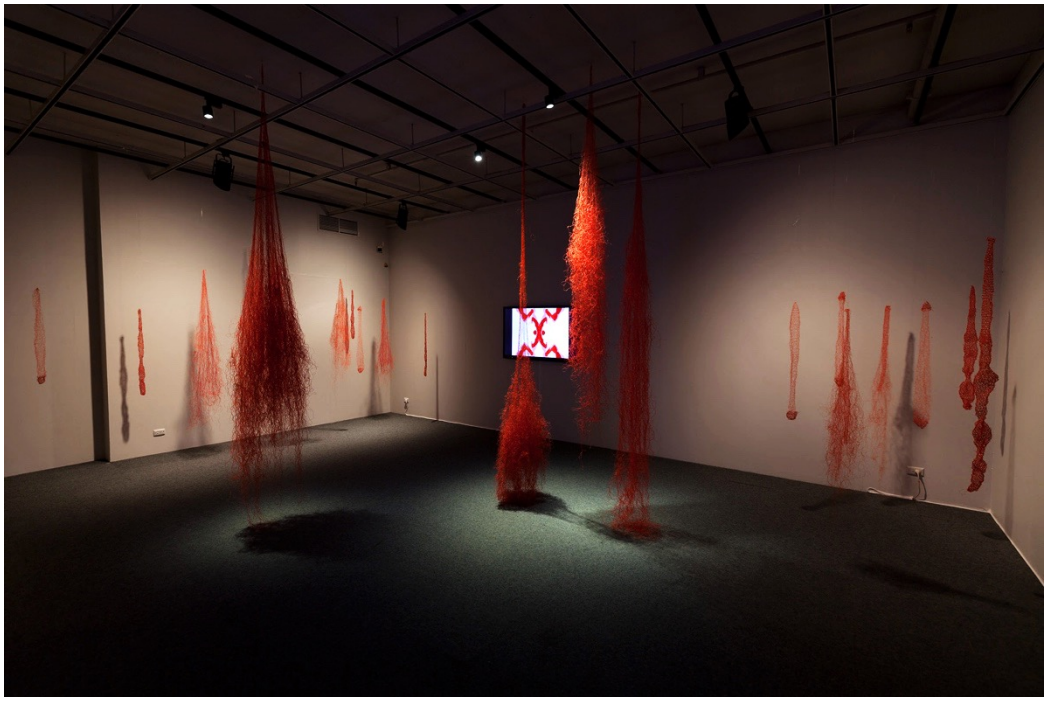
Linda Erceg, *Biomorph Yellow*, 2014, examination submission, 2017, photographs: Michelle Powell.

As the viewer passed deeper into the contained spaces, the scale of the structures grew larger; coiling or hanging down from ceiling to floor. The viewer was required to physically negotiate a path between, around and under the forms of *Growth System 1* and *3*.

Linda Erceg, *Growth System 1 and 3*, 2016, examination submission, 2017, photographs: Michelle Powell.

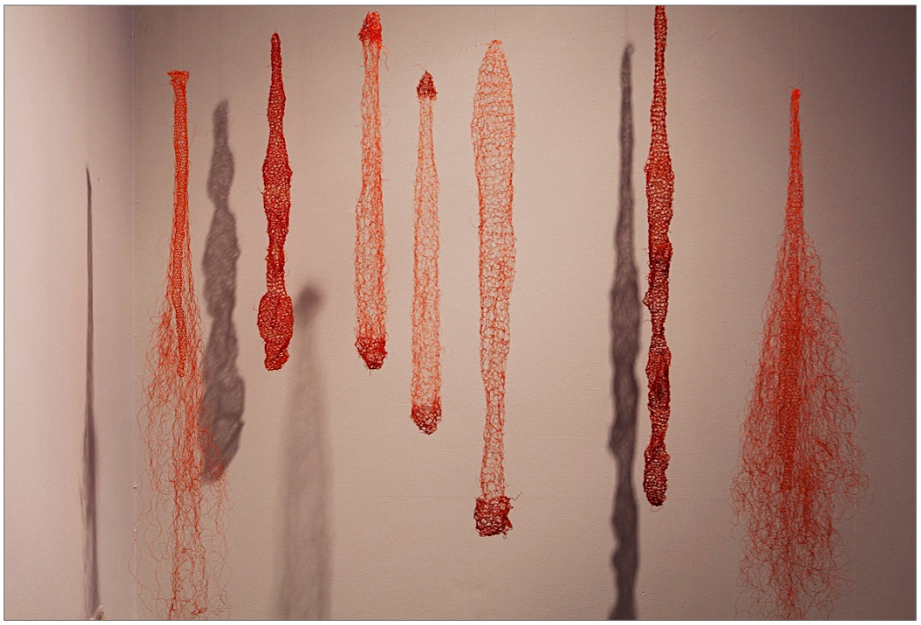
Linda Erceg, *Growth System 1,* 2016, examination submission, 2017, photographs, top: Linda Erceg, bottom: Michelle Powell.

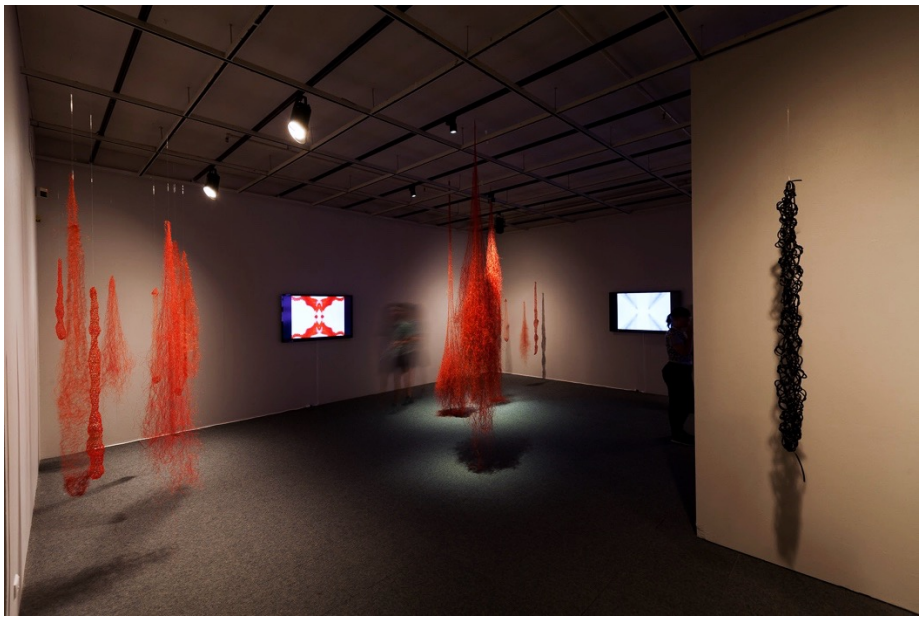
Entering the last room, the seven hanging forms of *Surface Tension/Looping Line* led to the multiple hanging pouches of *Biomorph Red*.



Linda Erceg, *Surface Tension/Looping Line* 2012, and *Biomorph Red*, 2013, examination submission, 2017, photos: Michelle Powell.

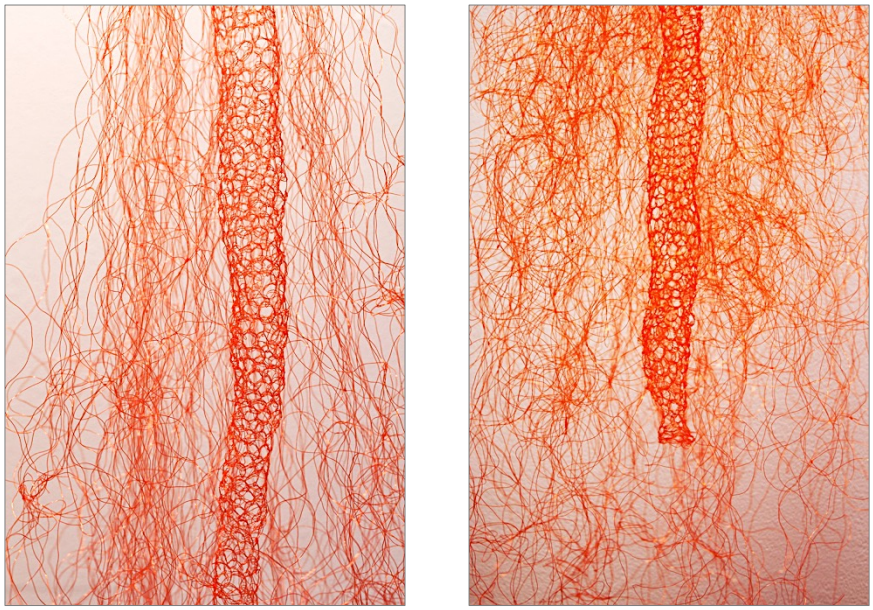
Wall-mounted monitors in this last room displayed video loops of *Stitch and Code*, creating a visual rhythm of merging and parting filaments that could be viewed through the suspended meshes of *Biomorph Red.* The abstract soundscape of gurgling, pulsing and ticking, travelled back through to the other spaces, providing both a directional guide and an additional sensory dimension to the viewer's experience.

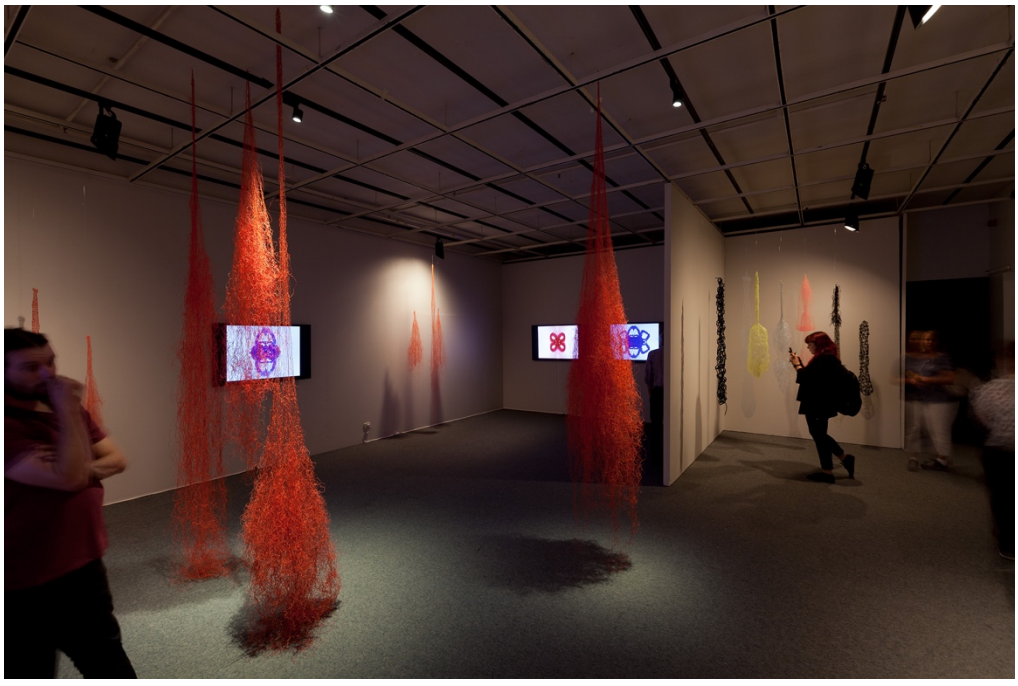




Linda Erceg, *Surface Tension/Looping Line*, 2012 and *Biomorph Red*, 2013, examination submission, 2017, photos: Michelle Powell.

Upon reaching this furthest point in the exhibition, the viewer then had to back-track in order to exit. In doing so, they revisited each work, which was now reversed spatially and seen in the chronological order of creation. As they retraced their journey, they negotiated a new path and in that process, allowed new experiences, connections and meanings to emerge.





Linda Erceg, *Surface Tension/Looping Line*, 2012 and *Biomorph Red,* 2013, examination submission, 2017, photographs: top: Linda Erceg, bottom: Michelle Powell.